# WHY ELECTRIC UTILITY STOCKS ARE SENSITIVE TO INTEREST RATES

By

EDWARD S. O'NEAL

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1993

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to the many people who have given their time and experience in assisting me with this project. My committee--Mark Flannery, Mike Ryngaert, Gene Brigham and Sandy Berg--have been extremely patient and helpful. I would also like to thank collectively the rest of the finance department faculty, graduate students, and secretaries for their help and understanding. Matt Billett and Jon Garfinkel have been especially generous with their time, effort and resources.

I would also like to thank my family and friends whose encouragement was crucial to the undertaking of the Ph.D. program. My father and mother, Ben and Mary O'Neal, and my sister, Eve O'Neal, deserve special mention for their support.

A special note of thanks goes to my wife who has supported me (spiritually and financially) throughout this painstaking process. Without her patience and understanding, this project could not have been completed.

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Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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By

Edward S. O'Neal

August, 1993

Chairman: Mark J. Flannery
Department: Finance, Insurance and Real Estate

Two separate factors are hypothesized to influence the interest rate sensitivity of utility stocks. First, the regulatory lag faced by utilities causes an earnings sensitivity to changes in inflation. Since interest rates contain an expected inflation component, the inflation sensitivity of utility earnings is manifested in the observed stock sensitivity to interest rate fluctuations. Second, many investors view utility stocks as suitable fixed income substitutes due to their high yields and relative safety. This pervasive investing strategy causes utility stocks to exhibit the interest rate sensitivity characteristic of true fixed income securities. Statistical results are consistent with the existence of both a regulatory lag effect and a fixed income effect.

# CHAPTER 1
# INTRODUCTION

Numerous studies have documented interest rate sensitivity of common stocks (see Stone, 1974; Sweeney and Warga, 1986; Flannery and James, 1984). These studies show that stocks in the banking industry and the utility industry are the most consistently sensitive to interest rates. Reasons for bank stock interest rate sensitivity have been explored by Flannery and James (1984), Kane and Unal (1990), and Akella and Greenbaum (1992) among others. These studies agree that the maturity mismatch between assets and liabilities of financial intermediaries causes the observed interest rate sensitivity.

Conversely, there is a conspicuous lack of research exploring the specific reasons for utility stock interest rate sensitivity. Two possible reasons for the observed sensitivity are examined in this study. The first is regulatory lag, a vestige of rate of return regulation which utilities face. The second is the idea, held by many in the investment community, that utility stocks are suitable substitutes for fixed income investments.

The regulatory process prevents utilities from changing output prices without resorting to lengthy rate case

litigation. One side effect of this process is that prices cannot change rapidly to reflect fluctuations in input costs. Thus in periods of increasing inflation, utility earnings are adversely affected as input costs rise but output prices remain stable. Similarly, periods of deflation are marked by falling input costs and utility earnings which benefit from stable prices. This earnings sensitivity to inflation is manifested in the observed sensitivity to interest rates. I term this idea that regulatory lag affects the interest rate sensitivity of utility stocks the *regulatory lag hypothesis*.

A second possibility is that utility stocks are interest rate sensitive because investors value them as fixed income substitutes. The characteristics of being safe relative to other stocks and having a high dividend yield may make them an attractive investment to investors desiring a safe, fixed income stream. This *fixed income hypothesis* predicts that utility stocks will shadow the price movements of government and corporate bonds because they are seen as alternatives to such fixed income investments.

I find evidence that both the fixed income nature of utility stocks and the regulatory lag that utilities face influences observed interest rate sensitivity of these stocks. In statistical analysis including proxies for *both* the degree of fixed income nature and the severity of regulatory lag faced, the fixed income characteristics appear to be the dominant reason for utilities' interest rate sensitivity.

The rest of this paper is organized as follows. Chapter 2 reviews the literature pertinent to this study. This section begins with an overview of rate of return regulation and regulatory lag. Chapter 3 presents formally the regulatory lag hypothesis. The fixed income hypothesis is discussed in chapter 4. Data are described in chapter 5. Empirical results are presented and discussed in chapter 6. Chapter 7 presents some directions for future research, and chapter 8 concludes.

# CHAPTER 2
# LITERATURE REVIEW

Public utilities are generally considered natural monopolies. They are able to provide their product or service more efficiently to a particular area than could multiple companies operating in a competitive environment. In order to minimize social costs, utilities are granted a franchise to be the sole provider of their service in an operating area. This unique government-granted franchise creates the potential for extracting monopoly profits from consumers. Utilities are therefore regulated in a manner to provide them with a "fair" rate of return. While the theory behind rate of return (ROR) regulation is simple, the application of the theory in practice is quite complex. In this chapter, section 1 discusses the general aims of regulation in the U.S. Section 2 outlines the theory of ROR regulation and section 3 discusses the application of ROR regulation. Section 4 demonstrates why this study is important in regard to the regulatory process facing utilities.

## 2.1 Aims of Regulation

The general goal of regulation can be broken down into four aims. While these aims are not completely separate in practice, it does help conceptually to think of them as different. These aims as discussed here are monopoly control, consumer protection, simulation of competition and social allocation of resources. This breakdown follows closely from Farris and Sampson, Ch.10.

As mentioned above, utilities usually operate as monopolies. Historically, the monopoly status has been granted because the service utilities provide is produced with a decreasing cost function over the vast majority of operating levels. The minimum cost production of service is thus achieved by one large supplier rather than a number of smaller suppliers operating in a competitive environment. One aim of regulation is to control the utility service sector such that there exists only one supplier. This means that regulators must grant a license for operation and set up barriers to entry.

While regulators grant utilities the right to operate in a given service area effectively as a monopoly, regulators are also saddled with the responsibility of insuring that utilities do not abuse their monopoly status. Thus the second aim of regulation is to protect consumers from monopolistic abuse. This abuse can take several forms, the most obvious of

which is pricing service above what is considered "fair value." This unfair pricing will lead to excessive profits at the expense of consumers. Pricing must also be controlled to be nondiscriminatory. A final abuse that must be thwarted is the tendency toward poor quality of service which arises when prices and earnings are set at low levels.

A third aim of regulation which is closely related to consumer protection is to simulate a competitive result. Under competition, a number of the problems that regulators are forced to deal with would resolve themselves. Prices would approach marginal costs. Consumers who were discriminated against by one producer would be supplied by another. Poor quality suppliers would be forced to raise quality, reduce prices, or lose market share. However the idea of simulating a competitive result goes beyond these consumer protection issues. Competition tends to lead to optimal allocation of resources. Raw materials, natural resources and technologies are employed in a socially optimal manner. An admittedly lofty (probably unattainable) goal of regulation is to achieve this optimal resource allocation that would attain in a competitive environment.

While simulating a competitive outcome is a major aim of regulation, regulators are also sensitive to the fact that pure competition can be harsh on certain clienteles. A final goal of regulation is to achieve social allocation of resources in a "fair" manner. The definition of fair in this

case is certainly vague. An example of what regulators deem unacceptable is outlying customers not being provided service because it is too costly to link them to the distribution network. Under strict competition, these customers would not be provided service unless they could pay for the cost of linkage to the network. A second example of an unfavorable result under strict competition is lack of utilities' concern for the environment. Regulators have taken it upon themselves to require utilities to be sensitive to ecological and environmental issues.

The four broad aims of regulation discussed in this section are obviously closely related, and it may be difficult at times to place regulatory actions under only one of these aims. Regulation in practice is a hodgepodge of these aims and certain aims tend to take precedence when resolving certain issues. The rate of return regulation that applies to most electric utilities has as its base the aims discussed here. The unique aspects of rate of return regulation are discussed in more detail in the following two sections.

## 2.2 ROR Regulation in Theory

Rate of return regulation is an attempt to grant a return on a firm's assets or capital that is commensurate with the risks borne by the investors in the firm. This can be accomplished by following a three step procedure (Brigham and Tapley, 1986): 1) Determine the assets necessary to provide

the given level of service. 2) Realize that the money required to acquire these assets must be raised in the capital markets. 3) Grant prices on the service such that the investors providing the capital are compensated in a "fair" manner. Usually this means granting prices such that the return on assets is very close to the cost of capital.

Step 1 above is specifically concerned with the valuation of utility firm assets. The two most prevalent methods for valuing utility assets are the original cost method and the reproduction cost method. The original cost method is the most straightforward and most widely used. Under original cost, only those assets that are currently used in the production of service are considered. These assets are valued at the price originally paid, less accrued depreciation. Most state commissions may also rule that certain acquisitions are or were imprudent and may thus exclude certain assets from the rate base or allow only portions of the original expenditures. Any assets acquired that are not directly useful in the provision of service (i.e., assets used for nonregulated businesses) are not included.

Quite obviously, the original cost method for valuing firm assets could itself have an effect on the stocks of utilities. In periods of rising costs, existing assets remain in the rate base at prices that may be clearly below current replacement prices. Since rates of return and ultimately allowed profits are based on these obsolete prices, utility

earnings will be adversely affected in these inflationary periods. A key advantage of the reproduction cost method is that these adverse effects are somewhat mitigated.

The reproduction cost method is more difficult than original cost but arrives at a result which is closer to market determined values. The basic premise behind the reproduction cost method is that assets should be valued at the level it would take to substantially reproduce the assets in their current form at current price levels. The task of valuation can be approached either through appraisals of current assets in place, or by adjusting the original costs of assets up or down depending on recent economic conditions.

Step 2 of ROR regulation requires that regulators consider the percentage returns utilities require on their assets to attract investors. The major undertaking in this step is to determine the cost of capital for the utility. Traditional methods for cost of capital calculations are used for utilities.

Of primary interest to equity investors are the allowed returns on equity. These allowed rates are generally based on the cost of equity calculations typical of cost of capital analysis. The CAPM approach, discounted cash flow and bond yield plus risk premium are all used by public utility commissions. Each of these methods has strengths and weaknesses. If commissions do not estimate the cost of and

return on equity close to what the market requires, utility stock prices will be affected. Current stockholders would benefit (at the expense of ratepayers) if the costs were estimated too high and would be hurt if costs were estimated too low.

Finally, rates must be set to provide the utility with the percentage returns that are deemed adequate in step 2. Pricing of utility services can be very complex, owing to a number of unique characteristics of the industry. High levels of fixed costs, an unstorable output, the perception of the service as a necessity and the requirement of having a high level of excess capacity are a few of the characteristics that together cause pricing policies to become complicated. In addition, the utility faces at least three separate classes (residential, commercial and industrial) of customers with different demand elasticities. Farris and Sampson state in a summary of utility pricing policies (p.234):

> Ideally a "good" rate or rate structure should meet several criteria. Among other things, it should be reasonable and not unduly discriminatory. It should provide a relatively stable cash inflow to the firm, while enabling the firm to maintain its financial integrity. It should reflect economies of use and of scale and share these economies with consumers, without waste or misallocation of economic resources. It should be convenient for the customer to pay and convenient and inexpensive for the firm to collect. And from a public relations viewpoint, it should be easy for a customer to understand the basis upon which he is charged. Needless to say, not all rates meet these criteria.

This section has discussed the theory behind rate of return regulation. It has touched on a few of the problems inherent in the regulation itself. The following section

presents further problems that arise with the application of ROR regulation.

## 2.3 ROR Regulation in Practice

In reality, the application of ROR regulation is not nearly as simple as outlined in section 2.2. A myriad of problems arise which must be addressed specifically for each situation where ROR regulation is being enforced. This section will discuss a number of these problems.

ROR regulation is generally applied in the following manner. First a utility, usually because of increasing costs, will apply to its respective commission for a rate hike. The firm will gather data over a particular test year period. This test year is usually over the preceding year (historic test-year period) although some commissions allow the use of a future test-year period. A hearing is convened at which regulators consider the firm's reasons for requesting the rate increase. The hearing may also see public interest groups testify against the proposed increase. In addition to testimonies for and against the rate increase, the commission has a staff to study the technical merits of the rate case. The commission then determines whether to allow the rate increase. This ruling may allow the entire increase, a portion of the increase, or none of the increase requested.

A rate case may also be initiated by the commission itself. These types of rate cases generally occur when the utility's input prices are observed to be declining or when the commission perceives that the utility is operating inefficiently. In these types of cases, the commission is pursuing a rate decrease and the utility generally presents evidence against all or part of the decrease. Once a ruling has been made in any rate case, the utility may file an appeal in the state appellate court system on the basis that the ruling is "unfair."

The ROR process is plagued by a number of problems. One basic economic problem is that of determining accurate cost and demand schedules for the service being produced. Costs for additional capacity are often unpredictable due to the fact that new technologies are utilized and regulations regarding the use of these technologies are changing. Likewise, demand schedules for the different types of customers being served are difficult to predict in the face of changing prices and political calls for conservation.

What should be allowed as recoverable costs is also a dilemma. Obviously, the utility will have the incentive to exaggerate costs. By overstating costs, the utility can increase its dollar return while still remaining within the rate of return limits imposed by the commission. There may also be costs, such as advertising and contributions, incurred by the utility that are not in the best interests of the

consumers. The commission, representing the consumers, polices the utility to insure that consumers only pay for what they should. Unfortunately, determining recoverable costs is as much an art as a science. While utilities might err on the side of including too much as recoverable costs, commissioners who are often subject to political pressures may disallow more than is appropriate.

The size of the rate base is another question which must be addressed. Should all assets in place be considered in the rate base or only those assets which are currently in use? Since the addition of extra capacity is lumpy in most utility businesses, situations are often faced in which the addition of extra capacity leads to extended periods of excess capacity. In general, most public utility commissions allow the inclusion in the rate base of only those assets which are currently being used to provide service. This policy means that funds used for construction work in progress (CWIP) do not earn a cash return for the utility. Some commissions do allow CWIP to earn an accounting return through "Allowance for Funds Used During Construction" or AFUDC.

Once the rate base is determined, the rate of return must be settled. As pointed out earlier, the rate of return should be based heavily on the utility's cost of capital. However, determining the appropriate cost of capital is difficult. Questions arise as to whether regulators should look at the entire utility industry or just certain firms when deciding on

a comparable cost of capital. Should a historical or future cost of capital be used? Also, the appropriate capital mix should be considered. Is there a capital structure that will minimize the cost of capital? The determination of the rate of return for a utility must take all of these problems into account.

How rigidly a firm should be regulated must also be addressed. Rigidity tends to remove incentives for efficiency. If a firm is controlled to the extent that it always earns an exact return on assets, little incentive is left for improving operations. To encourage efficiency, the rate of return can be set slightly below the cost of capital. Thus, a utility must strive to earn the return required by its investors.

The existence of regulatory lag also tends to encourage efficiency. Regulatory lag is the time period between when costs change and when the utility's prices change. If a utility can implement cost-saving procedures, profits will be affected positively until new rates are authorized which take into account this heightened efficiency.

## 2.4 Regulatory Lag

Regulatory lag is the focus of subsequent empirical work in this study. Several researchers have explored regulatory lag as it relates to public utilities. Both costs and benefits of regulatory lag are hypothesized in these papers.

The most prominent of these studies are reviewed here to provide some background on regulatory lag and its effects on public utilities.

As mentioned earlier, regulatory lag can be thought of as the time period between when input, production or capital costs change and when utilities are able to change rates to compensate for these cost increases. The lag exists because utilities are regulated so that prices may not be changed without the consent of the utilities' respective public utility commission. The most obvious effect of this regulatory lag is that utilities theoretically must endure a period in which costs have risen enough to push the return earned by the utility below levels acceptable to creditors and investors. The decreased return continues until a new rate ruling allows the utility to increase its return through higher rates. Evidence presented in this study is consistent with the negative effect of regulatory lag on earnings.

However, several researchers have pointed out that regulatory lag may have positive firm and societal effects. The most widely recognized positive effect is that regulatory lag may increase the efficiency of regulated firms. To see this effect, it is necessary to outline how public utility regulation in and of itself tends to discourage efficient firm operation; it does so for two related reasons. First, there is no competition for the utility's services. Innovation and efficient operation which would normally result from

competitive forces is thus retarded. In lieu of competition, regulators try to ensure that utilities adopt cost-saving strategies and innovations that would normally be adopted if the firm were operating in a competitive market. Rates are then mandated so that the utility will earn a return commensurate with a similar risk firm in a competitive environment. The rate-setting process is the second reason that innovation is discouraged because the rate of return that the firm can expect to earn is the same whether or not the innovation is adopted. The innovation ultimately saves only the firm's customers. In addition, the regulators' job of determining the efficiency of the firm is difficult and firms are thus less apt to innovate by their own accord. To summarize, utilities do not have the incentive for cost-saving innovation because the return they earn will be the same whether or not the innovations are adopted.

The existence of regulatory lag may serve to mitigate this negative effect of regulation on innovation. Bailey (1974) develops a model of regulation which takes into account regulatory lag. The lag period allows the firm to enjoy the profits from innovation until the next rate review lowers rates to take the new efficiency into account. The lowering of rates transfers the benefits of the heightened efficiency from the firm to the consumers. In Bailey's model, the role of the regulator is to choose the length of the lag that most benefits consumers. The analysis hinges on the fact that an

increase in lag time increases the firm's propensity to innovate but also increases the delay before customers benefit from innovation. A short lag time will get customers the benefits quicker but will provide less incentive for the firm to innovate. The model is solved so that an optimal level of regulatory lag is found. The optimization takes into account the cost of research and the cost of funds for the firm. The optimal lag time increases with an increase in either the cost of research or the cost of funds for the firm.

Similar models with similar conclusions are developed by Baumol and Klevorick (1970) and Klevorick (1973). Their models define the firm's output as a function of capital, labor and knowledge. They contend that the relationship (even the direction of the relationship) between regulatory lag and knowledge or innovation depends on the nature of the production function. Longer lag times could reduce innovation, but only under certain perverse (and unlikely) production functions. The majority of plausible production functions show a positive relationship between regulatory lag and innovation.

Sweeney (1981) shows that, though regulatory lag will indeed generate innovation, regulated firms can maximize the present value of those innovations by delaying their adoption. Hence, the benefits to society are lessened as the firm captures a greater portion of the profits from innovation. The incentive to delay innovation can be illustrated by

imagining a regulated firm which has discovered an innovation that can be easily implemented all at once or implemented as a three step process. If the implementation takes place in one period, the firm garners super-normal profits over the first period until new rates take into account the increased efficiency of innovation. If the implementation is carried out over three periods, the firm earns super-normal profits in each period, though the profits in any one period are not as large as under the single period implementation case. However, with elastic demand for the service, output quantity increases after each of the three periods' rate reductions. This increase in quantity causes the cumulative profit over the three period implementation to be greater than the one period implementation profit. The conclusion to be drawn from Sweeney (1981) is that regulatory lag does give incentive to innovate, though the social benefit is lessened due to slow implementation of innovations.

Bailey and Coleman (1971) show that regulatory lag tends to mitigate the Averch-Johnson (A-J) distortions. Averch and Johnson (1962) show that a firm under traditional rate of return regulation will tend to produce at a higher capital to labor ratio than under strictly competitive conditions. This increased use of capital is inefficient from a social welfare standpoint. It results because regulators allow a firm to earn what they deem a fair rate of return on the capital that is employed to provide service. Since their are numerous

capital-labor combinations that will produce a given level of service and since the total profit of the firm is directly related to capital, firms tend to substitute capital for labor in the production function.

The Bailey and Coleman (1971) study relies on the fact that there are costs to holding increased capital when regulatory lag exists. The costs are incurred because the firm must operate during the period between which the capital is obtained and the rate review process concludes. During this period, the firm is not earning a return on the recently obtained capital. They are, however, paying for the capital in the form of interest or dividend payments. The longer the regulatory lag, the more expensive it is for the firm to hold this excess capital. The resulting analysis shows that for large enough regulatory lags, the level of A-J overcapitalization will decrease.

A more recent article by Rogerson (1992) contends that under current depreciation methods, firms will tend to undercapitalize in the face of regulatory lag. This undercapitalization results because the capital which firms write off as depreciation in any one period is then not considered in the rate base for future periods. Thus the return to the firm is reduced if large amounts of depreciation are taken in the period before a rate case. If regulatory lag did not exist, then the entire amount of capital acquired at any one time would instantaneously be included in the rate

base and would earn a return for the firm. Therefore, the introduction of regulatory lag causes a tendency towards undercapitalization.

Also of interest is the fact that productivity changes due in part to technological advancements may offset some of the detrimental effects of regulatory lag. Regulatory lag is detrimental because costs are increasing and prices are not. However, even in the face of increasing costs, productivity advancements can blunt the effect of rising costs and may even allow a firm to decrease total costs. Thus technological changes may mitigate the detrimental effects of lag.

To summarize the literature reviewed in this section, it is apparent that there are both costs and benefits to regulatory lag. The obvious cost is that firms may operate over some periods when rates are unfairly low (a detriment to the utility) or unfairly high (at the expense of consumers). There is no guarantee that the periods of unfair customer expense will be evened out by equally severe periods of unfair firm expense. The benefits can be separated into two categories. First, regulatory lag can substitute for some of the effects of competition. Namely, lag periods might encourage innovation that regulated firms would eschew without lags, though innovation might not be as timely as would be observed in competitive markets. Second, it appears that regulatory lag might lessen the overcapitalization that is predicted by Averch-Johnson analysis. Both of these benefits

must be weighed against the inherent cost of regulatory lag, namely that periods occur when rates are unfair either to firms or customers.

This study presents evidence that is consistent with regulatory lag affecting earnings of utilities. It is shown that unexpected changes in inflation impact the returns to utility common stocks. This causes utility stocks to display a sensitivity to interest rates.

## 2.5 Background Literature

Stone (1974) is the first to suggest use of a two-index model for explaining equity returns (with the indices being a market proxy and an interest rate proxy). He notes that bank stocks and utility stocks both exhibit sensitivity to interest rates as well as the market.

Several studies look at the interest rate sensitivity of bank stocks. Flannery and James (1984) examine the returns of 67 publicly traded commercial banks and 26 savings and loans in a model where an interest rate factor is added to the traditional single factor market model. This formulation allows for sensitivity to a market index as predicted by the CAPM as well as any effects due to interest rate fluctuations. Weekly stock returns over a six-year period (1976-81) are regressed against the market index and the interest rate proxy. They find a strong negative relation between the returns to financial intermediary common stocks and interest

rates. Further, they find that this sensitivity results from funding long term assets (loans) with short term liabilities (deposits). A rise in interest rates will be quickly reflected in the short term cost of funds for the bank, but will be slowly incorporated into the long term sources of funds. Hence an interest rate rise will temporarily hurt the earning performance of banking firms. Likewise, a decrease in interest rates will temporarily benefit bank earnings. These shocks to earnings are reflected in bank stock prices. This result is termed the maturity mismatch hypothesis.

Aharony, Saunders and Swary (1986) also find that bank stocks are sensitive to interest rates. Unlike Flannery and James, they orthogonalize the interest rate proxy with respect to the market. This procedure insures that the significance on the interest rate factor is not affected by multicollinearity problems. Weekly returns for 73 bank stocks over a four-year period (October, 1977 through October, 1981) are used. An ARIMA model is fitted to the interest rate series so that an unexpected change in interest rates series could be created. This series is then regressed against the market and the resulting residuals make up the orthogonalized unexpected interest rate series. They find that bank stock returns are negatively related to this interest rate series.

Akella and Greenbaum (1992) also document the negative relation between interest rate movements and bank stock returns. In a twist of the Flannery and James methodology,

they show that the duration mismatch (as opposed to the maturity mismatch) between assets and liabilities affects the interest rate sensitivity. Akella and Greenbaum look at both long and short term bank assets and liabilities. This improves upon Flannery and James who look at only the difference between short term assets and liabilities and assume that this proxies well for the differences between all assets and liabilities. However, the findings of Akella and Greenbaum are quite similar to those of Flannery and James.

While no study to date has empirically tested reasons for utility stock interest rate sensitivity, several researchers have documented the sensitivity or explored related issues. Utilizing factor analysis, Bower, Bower and Logue (1984) find that an APT model has greater explanatory power than the traditional CAPM for four portfolios of utility stock over the period 1971-79. While the specific factors are not identified in a macroeconomic sense, this result is consistent with the theory that an interest rate factor may systematically affect utility stocks.

Sweeney and Warga (1986) regress monthly common stock returns over a 20 year period (1960-79) of 19 industries (classified by two-digit SIC codes) on a market index and a series of simple changes in long term interest rates. The only industry to demonstrate consistent sensitivity to the interest rate variable is the utilities industry. This

sensitivity is present over the entire 20-year period, in each 10-year subperiod and in each 5-year subperiod.

Unlike Sweeney and Warga who employ one interest rate proxy, Ehrhardt (1991) utilizes three interest rate variables to more completely represent the term structure. The three interest rate variables are defined as a short-term, a medium-term and a long-term factor. His procedure orthogonalizes each interest rate factor with respect to the market and the other two interest rate factors. For monthly data over the period 1969-85, he finds that utility stocks are significantly sensitive to all three interest rate factors.

Given that utility stocks are interest rate sensitive, a logical question to ask is "why?" To date there has been no research in this area. There have been, however, a host of articles describing and characterizing the properties of the systematic market risk of utilities. This literature will be touched on here because it may give us some clues as to why utilities experience interest rate sensitivity in addition to market sensitivity.

Not surprisingly, aspects of the regulatory environment faced by utilities have been theoretically posited as impacting the behavior of their common stocks. Regulation itself could reduce the risk faced by utilities. This risk reduction could be either a result of regulation or an objective of the regulatory process. Risk reduction may result from the attenuation of profit fluctuations which, in

a nonregulated setting, result from conventional demand and cost disturbances (Peltzman's, 1976, buffering effect). Alternatively, risk reduction may be viewed as desirable for the consumers and producers of the regulated good. In this case, regulatory agencies choose actions which deliberately reduce utilities' risk.

An opposing viewpoint is that the regulatory process increases the risk of regulated firms. One way this increase could come about is that rate of return regulation might distort the firm's factor mix, possibly increasing capital intensity. Lev (1974) shows empirically that an increase in capital intensity increases the systematic market risk of utilities. Alternatively, price stickiness imposed by the regulatory process might cause volatile profits in the face of rapidly increasing or decreasing input prices.

Norton (1985) examines the relationship between systematic market risk and differing regulatory environments faced by electric utilities. The utilities are placed into groups based on the strength of the regulatory agency in their state. Three groups are identified--strongly regulated, weakly regulated and unregulated. Market betas are found to be decreasing in the strength of regulation faced by the utilities. Additionally, Norton finds no evidence supporting the idea that utilities' systematic risk increases during periods of rapidly increasing factor prices (specifically, 1969-1974).

Keran (1976) looks at approximately the same inflationary period as Norton (1966-1973). Utility stock price behavior tended to be more closely related to bonds than to nonregulated industrial stocks during this period. During the preceding 11-year period (characterized by low, stable inflation), utility stock price movements more closely mirrored those of industrial stocks. Keran points to changes in the expectations of inflation coupled with the tendency of regulators to maintain constant nominal rates of return for utilities as the reason for his findings. Whereas Keran does not specifically address the issue of systematic market or interest rate risk, the findings are further evidence that utilities are influenced by interest rate changes.

A specific institution of electric utility regulation--the fuel adjustment clause (FAC)--has received considerable attention in relation to the systematic market risk of utilities. FACs allow utilities to pass through increased fuel costs to consumers directly without resorting to rate case litigation. Clarke (1980) argues that the use of FACs shifts some of the risk associated with fuel price fluctuations from stockholders to consumers. This shift will not only serve to reduce the total risk of utility stocks but will reduce systematic risk as well when fuel price changes are negatively correlated with market returns. Based on a sample of 39 firms that were allowed to implement FACs for at least one class of customers in the early 1970s, Clarke finds

that FAC implementation reduces systematic market risk by an average of 10 percent of the firm's initial market risk. The percentage change approaches 25 percent for those firms which are more heavily dependent on oil and gas than on coal.

Using a different sample period, Golec (1990) also explores the financial impact of FACs on electric utility stocks. During the period 1969-1983, 145 firm-specific FAC events are analyzed. In general, the effects on market risk of FAC events are small. The results show a weakly positive change in market betas when firms adopt FACs. The reason for the discrepancy between Clarke and Golec is likely the fact that during Golec's sample period, market returns and fuel price fluctuations were weakly positively correlated. Clarke's study was over a period which displayed negative market return-fuel price change correlation. Neither study addresses the interest rate sensitivity issue.

Interestingly, Sweeney and Warga's analysis, when combined with information documented by Clarke, lends marginal support to the regulatory lag hypothesis. Many electric utilities began utilizing fuel adjustment clauses (FACs) during the early 1970s as the price of oil increased. FACs allow electric utilities to pass on increases in fuel costs directly to consumers without filing formal rate cases. Widespread use of FACs began in the early 1970s; however, some utilities had been using them since 1965 (Clarke, p.349). Consistent with the timing of FAC implementation, Sweeny and

Warga find that the magnitude of utility stock sensitivity to interest rate changes decreases over the time period 1960-1979. This result can be viewed only as very preliminary support of a regulatory lag hypothesis.

Fuller, Hinman and Lowinger (1990) investigate the impact of nuclear power on the systematic market risk of electric utilities. 100 electric utilities are broken down into two groups--nuclear and nonnuclear. If the utility owns a nuclear plant that is in operation or is under construction, it is placed into the nuclear category. The time period studied is 1973-1988. Fuller et al. find that the market betas of nuclear utilities are significantly higher than those of nonnuclear utilities beginning in January, 1985. This timing corresponds approximately to the bond default of the Washington Public Power Supply System (WPPSS). Additionally, it was found that, ceteris paribus, the stocks of nuclear utilities sold at a significant discount to nonnuclear utilities in the time period after the Three Mile Island incident (1979-80). This discount is consistent with a two-factor APT model in which the factors are a market factor and a nuclear power factor. The pricing of this nuclear power factor is not explored.

Norton (1988) examines utilities' stock price reaction to the October, 1973, OPEC oil shock. He finds a significant negative reaction for a portfolio of utilities after controlling for the market reaction. The stronger the

regulatory environment faced by the utility, the less negative the reaction to the oil shock. This finding is consistent with regulation serving to buffer utilities against demand and cost shocks.

Spann (1976) simulates a model in which historic test year regulation is utilized. Under this type of regulation, prices are set based on average costs of the preceding period. Parameters of the model are estimated for a low inflationary period (1960) and a high inflationary period (1973). Profits of a utility facing historic test year regulation are extremely sensitive to the rate of inflation. In 1960, the present value of regulatory lags to utilities is positive while in 1973, it is highly negative. Spann is analyzing utility profits; however, stock prices would react in a similar manner to changes in inflation.

To summarize, no study has empirically tested reasons for utilities' sensitivity to interest rates. Characteristics of utility stocks' market risk have been the subject of numerous studies. Evidence that utility stocks are influenced by the regulatory environment, inflation and nuclear power production are all documented in the literature. Table 1 summarizes the literature reviewed in this chapter. This study will test the theories that regulatory environment (specifically regulatory lag) and the fixed income nature of utility stocks influences the magnitude of utilities' observed interest rate sensitivity.

Table 1: Articles which explore regulatory issues and their effect on systematic market characteristics of utility stocks.

| Author | Aspect of regulation studied | Main Conclusion |
|---|---|---|
| Lev (1974) | Capital Intensity | Shows empirically that an increase in capital intensity (as predicted by A-J) increases systematic market risk of utilities |
| Spann (1976) | Historic test-year regulation and inflation | Utility profits under historic test year regulation are extremely sensitive to changes in inflation |
| Keran (1976) | Nominal rates of return and inflation | Utility stock price movements are similar to bonds because of the tendency of regulators to maintain constant *nominal* rates of return |
| Clarke (1980) | Fuel Adjustment Clauses (FACs) | FAC implementation reduces systematic market risk of utilities |
| Golec (1990) | FACs | FAC implementation has little effect on the market risk of utilities |
| Norton (1985) | Strength of regulatory environment | Market betas are decreasing in the strength of regulation faced by utilities |
| Norton (1988) | 1973 OPEC oil shock | The stronger the regulation faced by a utility, the less negative the stock price reaction to the oil shock |
| Fuller, Hinman and Lowinger (1990) | Nuclear Power | Market betas of nuclear utilities are higher than those without nuclear capacity beginning with the WPPSS bond default |

# CHAPTER 3
# THE REGULATORY LAG HYPOTHESIS

As mentioned in chapter 2, no empirical work has directly touched on the reasons for utilities' interest rate sensitivity. Sweeney and Warga offer regulatory lag as a possible reason for this sensitivity. This chapter will formally develop the regulatory lag hypothesis.

Interest rates by definition consist of a real rate term and an expected inflation term. Given that utility stocks are sensitive to changes in interest rates, it follows that they must be sensitive to changes in the real rate, changes in expected inflation or both. The regulatory lag hypothesis suggests that the sensitivity is to either expected inflation or real rates. An expected inflation change will impact both the cost of capital for the utility and the cost of inputs such as labor and fuel. If the utility is not allowed to immediately change output prices, the increases in these costs cause a decrease in the profit the firm makes upon the sale of output. A real rate change affects primarily the cost of capital for the firm. The regulatory lag prevents the utility from changing output prices to compensate for increased capital costs. The way changes in interest rates affect

utility stocks can be illustrated in the following numerical example.

Two firms are identical in all respects except that one is regulated and the other is not. Assume a three period model. Each firm has assets in place that will produce a constant and certain output for the firm for periods 1, 2 and 3. The firms are completely equity financed and, for simplicity we will assume that they face a zero tax rate. The firms' stock price is simply the discounted value of a stream of nominal cash flows where the discount rate that applies to these firms is k = 10.25%. The discount rate can be broken down into a real rate and an expected inflation rate. The current and expected inflation rate is 5% and the real rate is 5%:

$$k = (1+R_r) * (1+ E(I)) - 1 \qquad (1a)$$

$$k = (1.05) * (1.05) - 1 = 10.25\% \qquad (1b)$$

Assume that the unregulated firm can change output prices at any time. Therefore, as inflation increases at 5%, increased costs are passed on instantaneously to consumers. Currently (at time zero) the cost of output produced is $100. The unregulated firm sets the price of output such that the profit margin (net income/sales) equals 15%.

Net profit margin = net income/sales

= (sales - cost of goods sold)/sales

$$= 1 - \text{cost of goods sold/sales}$$

$$.15 = 1 - 100/\text{sales}$$

$$\text{sales} = \$117.65$$

Therefore, at time period zero, the output sells for $117.65. However, all output is sold at the end of each year. Assuming that real rates and inflation remain constant, the stock price of the unregulated firm is

$$P_u = CF_1/(1+k) + CF_2/(1+k)^2 + CF_3/(1+k)^3 \qquad (2a)$$

$$P_u = [(117.65)(1.05) - 100(1.05)]/1.1025 + [(117.65)(1.05)^2 - 100(1.05)^2]/(1.1025)^2 + [(117.65)(1.05)^3 - 100(1.05)^3]/(1.1025)^3 \qquad (2b)$$

$$P_u = \$48$$

The regulated firm files a rate case at the beginning of each year. At that time the utility commission decides the price which the regulated firm may charge for its output when it is sold at the end of the coming year. The determined price takes into account expected inflation. Assume that the commission rules that a 15% profit margin on sales will generate the fair allowed ROE. If inflation remains constant at 5% through period three, the stock price of the regulated firm will equal that of the unregulated firm. This results because the commission will grant the regulated firm a 5% increase in price each year to account for expected inflation. In general, as long as the realized inflation is equal to the inflation expected at the time of the rate filing, the stock

price of the regulated firm will be identical to that of the unregulated firm.

Now consider the case where inflation expected at the beginning of year one is 5%. Immediately after the commission decides the rates that the regulated firm may charge, inflation jumps to an annualized level of 8%. Also assume that 8% inflation is then expected to last through period three. Now the two stocks will be valued differently. Whereas the unregulated firm is allowed to adjust prices at the end of year one to reflect increased inflation, the regulated firm must still charge prices determined when inflation was expected to be 5%. At the beginning of the second year, the commission will allow changes in prices to reflect the new expected inflation of 8%. The result is a difference in stock prices:

$$k = (1.05) * (1.08) - 1 = 13.4\%$$

$$P_u = [(117.65)(1.08) - 100(1.08)]/1.1025 + [(117.65)(1.08)^2 - 100(1.08)^2]/(1.1025)^2 + [(117.65)(1.08)^3 - 100(1.08)^3]/(1.1025)^3 \quad (3)$$

$$P_u = \$48$$

$$P_r = [(117.65)(1.05) - 100(1.08)]/1.1025 + [(117.65)(1.08)^2 - 100(1.08)^2]/(1.1025)^2 + [(117.65)(1.08)^3 - 100(1.08)^3]/(1.1025)^3 \quad (4)$$

$$P_r = \$44.94$$

The unregulated firm's stock price has not changed due to a change in expected inflation. The regulated firm's stock price has changed by \$3.06/\$48 = 6.4% for a 3% change in expected inflation. For each 100 basis point increase in expected inflation, the stock price of the regulated firm falls by 2.13%

Three additional points can be gleaned from the preceding example. First, the larger the magnitude of the change in expected inflation, the greater the impact on the regulated firm stock price. Second, the longer the time period between rate filings, the greater the price sensitivity to an unexpected change in inflation. This second point can be illustrated by assuming that regulators take two periods to adjust the regulated firm's prices. In that case, the price of the regulated firm stock would be:

$$P_r = [(117.65)(1.05) - 100(1.08)]/1.1025 + [(117.65)(1.05)^2 - 100(1.08)^2]/(1.1025)^2 + [(117.65)(1.08)^3 - 100(1.08)^3]/(1.1025)^3 \quad (5)$$

$$P_r = \$39.10$$

So for a 3 percent change in expected inflation, the stock price of the regulated firm falls by \$8.9/\$48 = 18.5%. The price sensitivity for a 100 basis point change in expected inflation is 6.18%.

The third point has to do with the completeness of the regulatory adjustment. In the preceding example it is assumed that the commission allows the firm to adjust prices so as to

completely offset the increase in costs by the very next period. If commissions tend to grant only partial price adjustments, this tendency would cause a greater stock price sensitivity to interest rates. As an example, suppose the commission, for some exogenous reason (such as keeping ratepayers from facing highly volatile rates), will not adjust the price by more than 1.5 percent per year. The price of the regulated stock would then be valued as:

$$P_r = [(117.65)(1.05) - 100(1.08)]/1.1025 + [(117.65)(1.065)^2 - 100(1.08)^2]/(1.1025)^2 + [(117.65)(1.08)^3 - 100(1.08)^3]/(1.1025)^3 \quad (6)$$

$$P_r = \$42.01$$

The price sensitivity for a 100 basis point change in inflation is 4.2%. It should also be noted that when an unexpected inflation decrease occurs, stock prices of regulated firms will increase relative to unregulated firms.

The question arises as to whether one would expect interest rate sensitivity to increase at an increasing or decreasing rate with regulatory lag. This question is important because the tests that are subsequently proposed will describe the interest rate sensitivity as some (perhaps nonlinear) function of regulatory lag.

An increase in expected inflation affects the magnitude of the future cash flows as well as the rate at which the cash flows are discounted. Since both of these terms are affected by expected inflation changes, it is not clear what the

correct relationship between regulatory lag and interest rate sensitivity should be.

The appendix shows that for rising inflation expectations, the interest rate sensitivity increases at a decreasing rate with regulatory lag. The opposite is true when expectations of inflation are falling. Under falling expectations, lengthening the regulatory lag increases interest rate sensitivity at an increasing rate.

In summary, an increase in expected inflation hurts regulated firm stocks while a decrease is beneficial, while the exact form of the relationship depends upon the direction of inflation changes. This hypothesis will be tested in chapter 6 by appealing to the fact that differences in regulatory lag exist across utilities.

# CHAPTER 4
# THE FIXED INCOME HYPOTHESIS

A short discourse on the investment banker sentiment on utility stock clientele is found in Brigham and Tapley (1986).

> Utilities have generally been regarded as safe 'widow and orphan' stocks suited for those who desire safe, assured income....More sophisticated investors (institutional investors) have largely abandoned utility stocks [such that] approximately 95% of utility stocks are held by individual investors....[These] investors are income oriented, generally retirees or on low fixed incomes... and not very sophisticated investors. The major competition for these investors' capital includes bonds, bank CDs and other securities oriented toward yield. (Brigham & Tapley, 1986, p.40.)

A recent practitioner article in Financial World dated August 4, 1992 quoted a Prudential Securities analyst: "If the economy continues to stumble, many equity investors will buy utilities. Those that generally look at utilities as bond substitutes will look at utilities as well. (Financial World August 4, 1992, p.10.)"

If in fact bank CDs and bonds are considered competition for utility investors' capital, it follows that utility stocks would display some of the characteristics of these fixed income instruments. The closer utility stocks are to substitutes for these securities, the more similarly they

should behave. Quite obviously bonds and CDs react to interest rate fluctuations due to their fixed income nature. If utility stocks are CD and bond substitutes, they too should react to interest rate changes. This is the *fixed income hypothesis:* that investors purchase utility stocks as alternatives to bonds and CDs because utility stocks have some of the same features--high yields and certainty. In order to test this fixed income hypothesis, it is necessary to identify the inherent characteristics particular to utility stocks that make them similar to fixed income securities. High yield and safety (relative to other stocks) are the two predominant "fixed income" qualities of utility stocks. Dividend yields of utilities ranged from an average of 11.2% in 1981 to 7.1% in 1988. These yields are highly correlated with T-bond yields over this period. Figure 1 graphs the quarterly dividend yields of the Dow Jones Utilities average and the yields on T-bonds over the 1980s. The correlation coefficient of these two series is .875 over the period. Because high yields (rather than capital gains) are desired by fixed income investors, the fixed income hypothesis suggests that the higher yielding utilities will be more bond-like and thus more interest rate sensitive than their lower yielding counterparts (which we must assume have as a larger percentage of their total returns capital gains). The methodology employed in chapter 6 will make use of the fact that there is

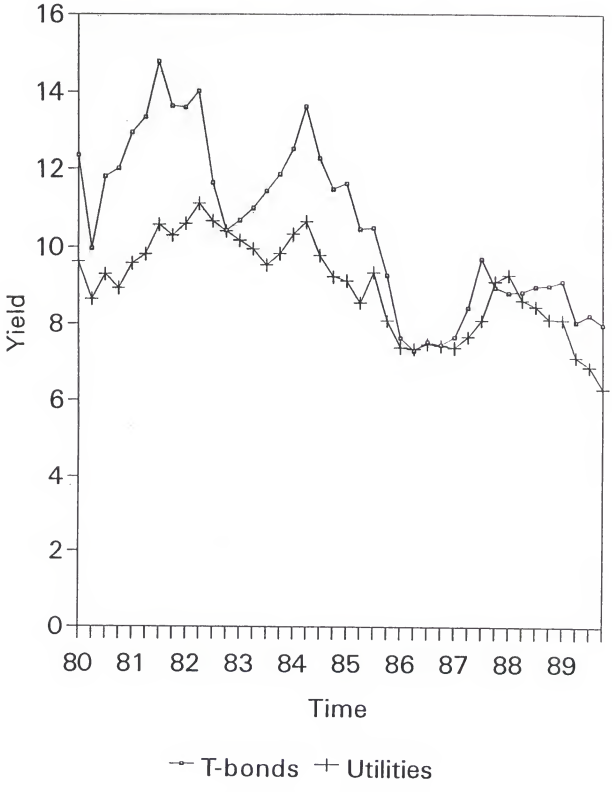


Figure 1: Dividend yields of Utilities, 1980-89.

considerable cross-sectional variation in dividend yields across electric utility stocks.

The second "fixed income" characteristic of utility stocks is that they are generally considered safe investments (relative to other stocks). Because they are a regulated monopoly, utilities may be buffered against demand shifts and cost shocks and thus perceived to be safer than most other stocks. For fixed income investors, the safety of the fixed income stream (as opposed to safety of capital gain income) is of most importance. The fixed income stream for utility stocks is, of course, the dividend stream. To the extent that cash flows (i.e., dividend streams or interest payments) are stable and safe, they will not respond to market changes, and hence the price of these instruments will vary inversely with rates. Therefore, if the dividend stream of utility stocks is perceived to be safer or more stable than that of other firms, then we would expect utility stocks to react to interest rates (as true fixed income securities do) more consistently than other stocks. Since this safety of a utility's dividend stream causes it to be consistently more interest rate sensitive than other stocks, differences in safety of dividend streams across utility stocks may help explain cross-sectional differences in interest rate sensitivity among utilities. The tests employed later will determine whether these differences in safety explain any of the interest rate sensitivity of utility stocks.

Over the early portion of this sample period, several utilities decreased or omitted dividends. This action may have caused the overall safety of the utility industry to decline. However, the tests developed will control for these dividend cutting actions on a firm specific basis.

It is necessary to identify variables which can proxy for the relative safety of a utility. Several accounting variables are identified which may reveal the safety of a firm's future dividend stream. These include *interest coverage, preferred dividend coverage,* and *common dividend coverage*.

$$\text{interest coverage} = \frac{\text{income before interest and taxes}}{\text{interest expense}}$$

$$\text{pref. dividend coverage} = \frac{\text{income before interest and taxes}/}{\text{(fixed charges + pretax preferred dividends)}}$$

$$\text{common coverage} = \frac{\text{(income after interest, taxes and preferred)}}{\text{total common dividends}}$$

Each of these gives a feel for how well a firm's earnings are meeting its required and promised payouts. If a firm exhibits low or deteriorating coverage ratios, the dividend stream may be jeopardized. The common dividend coverage is obviously most important for investors who are concerned about the safety of the dividend stream. However, the other two ratios should be related to the common dividend coverage and as such are included in the empirical tests of chapter 6.

A note here should be made about the inclusion of allowance for funds used during construction (AFUDC). AFUDC

is an accounting income that allows utilities to capitalize the costs of construction. AFUDC is figured as some percentage (theoretically a cost of capital number) of construction projects in progress. While the utility is not earning AFUDC in the form of a cash return, the AFUDC is appearing on the books. After the plant goes in service, the utility is permitted to include the AFUDC in the rate base and earn a cash return on it. The net income numbers above include AFUDC and as such may not be reliable estimates of the cash available to pay off debt and to pay dividends. Especially in the early 80s when large nuclear projects were prevalent, AFUDC may have been a significant percentage of net income. As such, the coverage ratios calculated may be biased away from being a significant explanatory variable of interest rate sensitivity. With this realization in mind, the coverage ratios are included in the subsequent analysis.

*Total assets* is included in the analysis. Investors may perceive large firms as more viable than smaller firms and thus better able to continue a high dividend payout strategy.

Finally, *debt to equity ratio* is offered as a characteristic that reveals an aspect of safety. Bhandari (1988) posits that an increase in debt to equity ratio increases the risk of a firm's common equity. While the risk he discusses is not specifically the risk that the firm's dividend stream is less certain, as the debt-equity ratio increases, the dividend payments do become more subordinate to

coupon payments. Bhandari goes on to show in his study that expected stock returns are positively related to debt to equity ratio even after controlling for firm size and beta. This result is support for his contention that higher debt equity firms are more risky and require higher returns. In my study, a more heavily levered firm's dividend payments may be seen as less certain than those of a firm with relatively little debt. Therefore, highly levered firm stock will be less sensitive to interest rates under the fixed income hypothesis.

It should be pointed out that Pearce and Roley (1988) show that a firm's debt to equity ratio is important in determining a firm's stock price reaction to unanticipated inflation. Specifically, highly levered firms react more positively to unanticipated inflation increases than low levered firms. This reaction results because firms' debt obligations are nominal contracts. When inflation unexpectedly rises, equity holders are better off because debt holders are locked in to the rates contracted on before the inflation increase. Therefore, equity holders benefit from the capital acquired at low rates.

With the realization that equity values are differentially impacted by unanticipated inflation due to their debt to equity ratios, it may be difficult to draw conclusions about why the debt to equity ratio affects interest rate sensitivity. Under Pearce, the effect may

simply be a manifestation of the fact that debt to equity ratios of all equities affect their sensitivities to unanticipated inflation.

In summary, utility stocks have been shown to react to interest rate changes in much the same way as fixed income securities. Safety of earnings and dividend streams and relatively high dividend yields make utility stocks a close substitute for fixed income investments. The variables described above will allow tests of whether cross-sectional differences in safety or yield affect the interest rate sensitivity of utility stocks.

# CHAPTER 5
# DATA

Several sets of data are required for the subsequent empirical testing. The first set must proxy for simple changes in long term interest rates. The series used in this study is the yields on 30 year US treasury bonds. These data are obtained from the DRI Financial and Credit Statistic (DRIFACS) database whose source is the Federal Reserve Bank of New York H.15 release. The rates are published for each Friday of the year. In weeks where Friday is a holiday, the rate is for the preceding Thursday. Interest rates are collected for every week from 1980 to 1989. This totals ten years or 522 weeks of data. The change in yield from one week to the next is calculated as the first difference. This yields 521 observations of changes in interest rates.

Next, it is necessary to identify a sample of utility stocks. A list of utilities that trade on the New York and American stock exchanges can be found in Public Utilities Fortnightly (PUF). This list divides the utilities into electric, electric and gas, gas, telephone and water utilities. In order to qualify for the study, the firm had to have stock traded continuously from January, 1980 to December, 1989 on either exchange. All electric utilities that meet

this criterion are included in the sample. The selection yields 44 electric utilities.

PUF also publishes information on gas, electric and gas and telephone utilities. Electric utilities only are chosen for this study so that the sample of firms is as homogeneous as possible. This homogeneity will allow stronger conclusions about the causes of interest rate sensitivity. For example, certain aspects about the telephone industry may contribute to interest rate sensitivity of telephone utilities but not to that of electric utilities. To avoid these confounding effects, only utilities from a certain industry are used (the electric utility industry).

The returns to the stocks of these companies are obtained from the Center for Research in Securities Prices (CRSP) tapes. Daily returns for each stock are converted into weekly returns. Weekly returns are Friday to Friday to correspond to the weekly interest rate data. Again, when Friday holidays are encountered, the preceding Thursday is denoted as the end of the week. The value-weighted market return is also gathered from the CRSP tape and converted into a weekly return.

Information on rate cases is necessary for quantifying regulatory lag. This data is available in PUF. Once a year, a list of rate cases that were authorized in the previous 12 months is published. Information on 740 electric utility rate cases is obtained. The date on which the rate case is filed

and the date on which the rate increase is authorized are the pertinent facts. The dollar amount of the rate base increase requested and the dollar amount granted is also collected. Some cases lack one or more of these variables. The final data set consists of full information on 630 rate cases.

Yearly accounting variables are collected from Compustat for each firm in the sample for 1979-89. The variables collected or calculated are dividend yield, interest coverage, preferred dividend coverage, common dividend coverage, total assets and debt-equity ratio.

## CHAPTER 6
## METHODOLOGY AND RESULTS

To illustrate the interest rate sensitivity of electric utility stocks during the 1980s, the 44 electric utilities in the sample are grouped into a single portfolio. The returns to this portfolio are then regressed against the market portfolio and a change in interest rate variable. The regression is of the form:

$$R_t = \beta_0 + \beta_1 R_{mt} + \beta_2 \Delta I_t + e_t \qquad (7)$$

where,

$R_t$ = return to the portfolio time period t

$R_{mt}$ = return to market proxy in time period t

$\Delta I_t$ = change in interest rate in period t.

The results of this regression are found in table 2. The coefficient on the interest rate variable is -.028 and is significant at any reasonable level of confidence. The R-square is .39 which is a significant increase over the R-square of .26 when the portfolio is regressed only against the market variable. The sample is broken down into two five year subperiods and the interest rate variable is highly

Table 2: Results of regression equation (7); utility portfolio vs. market and interest rate.

| Period | $\beta_0$ | $\beta_1$ | $\beta_2$ | $R^2$ |
|---|---|---|---|---|
| 1980-89 | .001<br>(2.10) | .35<br>(12.01) | -.028<br>(-10.55) | .39 |
| 1980-84 | .003<br>(3.01) | .29<br>(6.87) | -.027<br>(-8.28) | .40 |
| 1985-89 | .002<br>(2.18) | .44<br>(10.58) | -.033<br>(-6.87) | .39 |

Note: (T-Statistics in parentheses)

Table 3: Of 44 electric utilities, the number with significant interest rate betas in the 1980s.

| Number of utilities out of 44 | Significance level |
|---|---|
| 41 | .05 |
| 39 | .01 |
| 34 | .001 |
| 32 | .0001 |

significant in each subperiod. These results can also be found in table 2.

As a final demonstration of interest rate sensitivity of the sample, the returns to each of the 44 utilities in the sample were regressed against the market and interest rate variable as in equation (7). The results are presented in table 3. Of the 44 utilities, 41 had interest rate betas that were significant at the .05 level. Additionally, 39 were significant at the .01 level, 34 at the .001 level and 32 at the .0001 level. This evidence is offered here only to confirm the findings of previous research that utility stocks are indeed consistently sensitive to interest rates.

The rest of this chapter is devoted to determining if cross-sectional differences in the interest rate sensitivity of utility stocks can be attributed to regulatory lag or the fixed income nature of the stocks. Section 6.1 tests the regulatory lag hypothesis while section 6.2 looks at the fixed income hypothesis. Because the two hypotheses are not mutually exclusive, section 6.4 contains empirical tests that include both the regulatory lag variables and the fixed income variables simultaneously.

## 6.1 Testing the Regulatory Lag Hypothesis

To test the regulatory lag hypothesis, regulatory lag must be quantified. No previous research has addressed this issue. In this section four measures of regulatory lag are

developed and are subsequently utilized to gauge the impact of regulatory lag on interest rate sensitivity.

The data set used to calculate regulatory lag is collected from PUF. For 630 rate cases, the following information is available: 1) the date on which the case was filed, 2) the date on which the ruling was authorized, 3) the dollar amount of rate base increase requested, and 4) the dollar amount of rate base increase authorized.

A note should be made here about what pertinent rate case data is unavailable. Ideally, the actual prices charged per kilowatt hour of electricity for each utility in each month of the sample period would be collected. However, this information is not available on a monthly basis until January, 1991. These data would allow an accurate calculation of the lags utilities in the sample face in relation to other utilities. The prices charged could be compared to an industry average or a region average to determine whether they led or lagged most other utilities in price increases or decreases. These data could be used to see not only how quickly a utility's prices change, but how completely they reflect industry trends.

It would also be helpful to have access to monthly average costs of the production and distribution of a kilowatt hour of electrical service for each utility. This information, along with the price data, would allow comparisons of the profitability margins under which each

utility is operating. These data would also provide a measurement of how quickly each utility's prices change to reflect changes in input costs. This measurement would presumably be the best proxy for regulatory lag. However, the cost data is not available even for recent periods.

As mentioned, ideally these data could be used to construct "best" regulatory lag measures. However the measures constructed below incorporate the aspects of regulatory lag as well as possible with the data that is available.

The data that are available are grouped by state so that each state has a listing of rate cases for the 1980s. Each of the regulatory lag measures are calculated for each rate case and then averaged over all cases in each particular state. This procedure renders an average regulatory lag for each state. Subsequent analysis will determine whether interest rate sensitivity is influenced by the regulatory lag of the state in which the utility operates.

As pointed out in the example in chapter 3, both the length of time between cost and price increases and the degree to which adjustments are complete are important factors of regulatory lag. The first of these, which will be termed "time lag," is simply the time between a rate case filing and its subsequent authorization. Long time periods between rate case filing and rate case authorization generate longer regulatory lags. Therefore, regulatory lag is directly

related to time lag. This time lag is the first measure of regulatory lag in this study and is denoted RLAG1.

RLAG1 = the average number of days between rate case filing and authorization in a particular state

The second measure of regulatory lag takes into account not only the time lag but also the "adjustment lag." The adjustment lag is measured as the percent of rate base increase request authorized. A smaller number means that less of the request was authorized. The smaller the percentage, the less complete the adjustment and the longer the effective regulatory lag. Thus, regulatory lag is inversely related to the degree of partial adjustment. This measure is denoted RLAG2 and is quantified in the equation below:

RLAG2= RLAG1/[$ authorized/$requested]

RLAG2 takes into account the positive relation between regulatory lag and time lag (measured by RLAG1) and the inverse relation between regulatory lag and degree of partial adjustment.

A third measure is specified to take into account the time lag, partial adjustment and the relative magnitudes of the rate increases requested. When aggregating to assess a state PUC's average regulatory lag, simple averaging (as for RLAG2) suffers from the fact that a rate case decision that authorizes $5 million on a request of $10 million contributes

to regulatory lag the same as an authorization of $100 million on a request of $200 million. In fact, the larger rate cases have a greater potential impact on the regulatory lag experienced by utilities. To control for this size difference, each rate case in each state has an RLAG2 calculated. The rate cases in each state are then weighted by the amount requested in each rate case divided by the average amount requested in all rate cases. The weighted rate cases are then averaged for each state. This measure is denoted RLAG3.

Similarly, an RLAG4 is calculated that controls for the size of each rate case when the simple time lag of RLAG1 is utilized. This RLAG4 takes the time lag of each case and weights it by the amount requested in the rate case divided by the average amount requested in all rate cases for the state.

6.1.1. Tests with RLAG1

For each state, the RLAG1 measures for regulatory lag are calculated. The following grouping and testing procedure is then performed. The utilities are grouped by state. This grouping results in a regulatory lag measure for each utility in the sample. Next, the list of utilities is ordered by increasing regulatory lag. As a preliminary test, the sample is divided into two subgroups--those with regulatory lag above average and those with a regulatory lag below average. Table 4 lists the states in each subgroup. The average lag time for the short and long lag groups is 224 days and 310

Table 4: States represented in short and long lag portfolios. Regulatory lag measure is RLAG1.

| Short Lags | Long Lags |
|---|---|
| Delaware | Florida |
| Connecticut | Missouri |
| Nevada | South Carolina |
| Kentucky | Washington |
| Massachusetts | North Carolina |
| Maryland | Minnesota |
| Maine | Indiana |
| New Mexico | Illinois |
| Texas | New York |
| Idaho | Iowa |
| Oregon | Arizona |
| Kansas | Ohio |
| Pennsylvania | Louisiana |
| Georgia | |

days respectively. The difference of means test yields a Z-statistic of 8.1 which is significant well beyond the .001 level. Two equally-weighted portfolios of utility stocks are then formed--a short and long lag portfolio. Each portfolio consists of the stocks of the utilities that operate in the states in each of the lag groups. The weekly returns are then regressed in a system of equations similar to equation (7). The system is run as a seemingly unrelated regression system so that efficient cross-system comparisons of coefficients can be performed. The system is of the form:

$$R_{it} = \beta_{i0} + \beta_{i1}R_{mt} + \beta_{i2}\Delta I_t + e_{it} \qquad (8)$$

Where,

$R_{it}$ = return to portfolio i in time period t

$R_{mt}$ = return to market proxy in time period t

$\Delta I_t$ = change in interest rate from period t-1 to t

The coefficient of interest is $\beta_{i2}$. Table 5 shows the coefficients and their standard errors for both portfolios. The coefficients are indeed different and in the hypothesized directions. The portfolio of utilities facing short lags is less sensitive to interest rates than the portfolio of utilities facing long lags. A Wald test of the difference in these coefficients yields a chi-square statistic of 10.22 (p=.0015). At any reasonable level of confidence, the short

Table 5: Results of regression equation (8) for a short and long lag portfolio. Regulatory lag measure is RLAG1.

| | $\beta_0$ | $\beta_1$ | $\beta_2$ |
|---|---|---|---|
| Short Lag Portfolio | .002<br>(.0007) | .32<br>(.035) | -.024<br>(.0031) |
| Long Lag Portfolio | .002<br>(.0007) | .37<br>(.037) | -.029<br>(.0033) |

Note: Standard errors are in parentheses.

lag portfolio is less interest rate sensitive than the long lag portfolio.

The next step is to break the sample down into a finer set of subgroups. Similar tests can then be run on the resulting portfolios. First, the utilities are sorted by the regulatory lag to which they are subject. Second, quintiles are formed (of eight, nine or ten utilities each) that face differing degrees of regulatory lag. The stocks of the utilities in each quintile are combined to form equally-weighted portfolios. This yields five portfolios termed REG1 through REG5. The states represented in each group are shown in table 6. The mean regulatory lag in each group is shown in table 7. Difference of means tests are performed to determine if the regulatory lag facing each group is significantly different. The results are shown in table 8. Each group differs significantly from the other groups except for REG3 and REG4.

The SUR system in equation (8) is run for the five portfolios. The results from this estimation procedure for regulatory lag measure RLAG1 are found in table 9. The interest rate betas tend to increase as regulatory lag increases. However, the REG5 beta does not fall in line with those of the other four portfolios.

The next step is to determine whether the interest rate betas are statistically different at conventional confidence levels. Wald tests are run between each of the interest rate

Table 6: States represented in each portfolio grouped by regulatory lag. REG 1 has the shortest lags, REG 5 has the longest lags. Regulatory lag measure is RLAG1.

| REG 1 | REG 2 | REG 3 | REG 4 | REG 5 |
|---|---|---|---|---|
| Delaware | New Mexico | Penn. | N. Carolina | N.Y. |
| Conn. | Texas | Georgia | Minnesota | Iowa |
| Nevada | Idaho | Florida | Indiana | Az. |
| Kentucky | Oregon | Missouri | Illinois | Ohio |
| Mass. | | Kansas | S. Carolina | La. |
| Maryland | | Washington | | |
| Maine | | | | |

Table 7: Statistics on portfolios grouped by regulatory lag measure RLAG1.

| Portfolio | Mean Regulatory Lag (days) | Standard Deviation of Regulatory Lag | Number of Rate Cases |
|---|---|---|---|
| REG 1 | 186.7 | 70.65 | 84 |
| REG 2 | 232.4 | 134.5 | 89 |
| REG 3 | 271.9 | 114.3 | 92 |
| REG 4 | 291.1 | 92.26 | 89 |
| REG 5 | 337.1 | 114.7 | 101 |

Table 8: Z-statistics for differences in mean regulatory lag between portfolios. Regulatory lag measure is RLAG1.

| Portfolio | REG 1 | REG 2 | REG 3 | REG 4 | REG 5 |
|---|---|---|---|---|---|
| REG 1 | ---- | 2.82 | 5.85 | 7.23 | 10.92 |
| REG 2 | | ---- | 2.13* | 3.12 | 5.73 |
| REG 3 | | | ---- | 1.13** | 3.95 |
| REG 4 | | | | ---- | 2.75 |
| REG 5 | | | | | ---- |

Notes: * - Significant at the 5% level
** - Not significant at conventional confidence levels
No asterisk means significant at the 1% level

Table 9: Regression of regulatory lag portfolios on a market portfolio and an interest rate series. Regulatory lag measure is RLAG1.

| Portfolio | Market Beta | T-Statistic | I. Rate Beta | T-Statistic | $R^2$ |
|---|---|---|---|---|---|
| REG 1 | .40 | 11.6 | - .0247 | - 7.81 | .27 |
| REG 2 | .42 | 13.6 | - .0271 | - 9.68 | .35 |
| REG 3 | .46 | 14.0 | - .0305 | - 10.1 | .36 |
| REG 4 | .42 | 11.6 | - .0323 | - 9.77 | .31 |
| REG 5 | .50 | 13.9 | - .0303 | - 9.22 | .35 |

Table 10: Chi-square statistics for differences in interest rate sensitivity between portfolios with different regulatory lag. Regulatory lag measure is RLAG1.

| Portfolio | REG 1 | REG 2 | REG 3 | REG 4 | REG 5 |
|---|---|---|---|---|---|
| REG 1 | ---- | 1.15 | 5.90** | 8.86*** | 4.39** |
| REG 2 | | ---- | 3.22* | 5.34** | 1.57 |
| REG 3 | | | ---- | 0.71 | 0.01 |
| REG 4 | | | | ---- | 0.61 |
| REG 5 | | | | | ---- |

Notes: * - Significant at the 10% level
** - Significant at the 5% level
*** - Significant at the 1% level

coefficients. Results are found in table 10. The interest rate sensitivity of REG1 is significantly different from REG3, 4 & 5. REG2 is different from REG3 & REG4. Other test statistics are not significant.

These results with the finer partitioning are further evidence of a regulatory lag effect on the interest rate sensitivity of utility stocks. While *all* of the five groups do not appear to have different sensitivities, the failure to pick up differences between all of the portfolios is likely caused by the noisy regulatory lag measure. Because of the scarcity of rate case data, some states have as few as 5 rate cases over the entire 10-year period. This lack of data naturally causes the time lag to be measured with some degree of error. Additionally, the regulatory regime in some states may gradually change over time. Calculating the mean over a period of shifting regulatory climate will also lead to errors in the lag measure. However, with a shortage of rate case data, the sample cannot readily be split into smaller time periods.

A second test is designed to test the effects of regulatory lag on interest rate sensitivity by using the regulatory lag measure as an interactive variable with interest rate changes. Assume that the interest rate coefficient in equation (8) can be broken down into a constant term (due to the fact that all utilities are subject to interest rate sensitivity for reasons other than regulatory

lag) and a term that is determined directly by the regulatory lag. This formulation can be written as:

$$\beta_{2i} = \alpha_0 + \alpha_1 RLAG_i$$

where,

$RLAG_i$ = the regulatory lag faced by firm i.

The $\alpha_0$ and $\alpha_1$ terms can be estimated via the following regression:

$$R_{it} = \beta_{i0} + \beta_{i1} R_{mt} + [\alpha_0 + \alpha_1 RLAG_i]\Delta I_t + e_{it} \qquad (9)$$

where,

$R_{it}$ = return to <u>stock</u> i in period t.

A significant $\alpha_1$ term means that regulatory lag significantly impacts the interest rate sensitivity of the stock. Equation (9) is run as a system of seemingly unrelated regressions. The system contains 44 equations--one for each firm in the sample. The $\alpha_0$ and $\alpha_1$ coefficients are constrained to be equal across equations. Note that the individual stocks are being used in this test as opposed to the portfolios formed for the previous tests. Table 11 shows the results for this test.

The $\alpha_1$ coefficient is of the hypothesized sign but is not statistically significant at conventional levels. The $\alpha_0$ coefficient is significant meaning that the sample of utility stocks is interest rate sensitive for reasons other than regulatory lag (or at least other than this regulatory lag measure represents).

Table 11: Results of SUR of equation (9) when regulatory lag is measured by RLAG1.
System is run with individual securities.
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_i)\ ] * \Delta I_t \qquad (9)$$

| RLAG1 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG1 | -.017 | -4.76 | $-1.72*10^{-5}$ | -1.60 |
| ln(RLAG1) | .0017 | 0.115 | -.00413 | -1.55 |
| $RLAG1^2$ | -.019 | -7.12 | $-3.34*10^{-8}$ | -1.61 |

As stated in chapter 3 and shown in the appendix, the interest rate sensitivity may increase as an increasing or decreasing function of regulatory lag depending on the relationship between the expected inflation levels and the real rate. The previous test is altered so that the regulatory lag measure is $(RLAG1)^2$ and then altered a second time as ln(RLAG1). These two formulations give a measure which is increasing at an increasing rate and increasing at a decreasing rate. The test is run with these two new regulatory lag measures and the results are also found in table 11.

Again the results are of the correct sign but are not significant at conventional levels. Interestingly the T-statistics for all three RLAG1 measures (RLAG1, ln(RLAG1) and $(RLAG1)^2$) are all between -1.55 and -1.61 which have p-values of between .122 and .108--close to, but not significant at the traditional .1 level.

There is a noticeable outlier in the sample of utility stocks. The RLAG1 variable for Louisiana is the highest of all states although it is still of the same order as the remaining states. However, the sole utility in the sample that operates in Louisiana is Gulf States Utilities. GSU built the River Bend nuclear plant in the early 80s. The Louisiana PUC denied large rate increases in rate cases that took upwards of two years to resolve. In 1987, the Louisiana commission found that $1.6 billion of the River Bend project

was prudent but disallowed $1.4 billion on the grounds that a lignite coal plant should have been built. Over this period, stock of GSU is less interest rate sensitive than all other utilities in the sample. This low sensitivity is likely due to the fact that the regulatory rulings were unfavorable to the point that the dividend stream was jeopardized. The dividend was in fact reduced in early 1986 and omitted completely on August 7, 1986.

Though there is no valid reason for not including GSU in the analysis, it was deleted to see the effects on the interest rate coefficients. When GSU is deleted from the sample and equation (9) is estimated in a SUR for the remaining 43 utilities, the coefficients on RLAG1, ln(RLAG1) and $RLAG1^2$ are all significant at the .05 level. The results are presented in table 12.

Finally, the interactive analysis is run for the five quintiles identified for earlier tests of differing interest rate sensitivity. The formation of quintiles is described earlier in this section. Each quintile has a regulatory lag calculated as the average regulatory lag faced by the firms in that quintile. Five equally weighted portfolios are formed--one for each quintile. The returns to the portfolios are then run in a SUR of equation (9). The $RLAG1_i$s are just the RLAG1s calculated for each quintile. This procedure will reduce some of the measurement errors of the RLAG1 proxy, although this reduction in measurement error must be weighed against the

Table 12: Results of SUR of equation (9) when regulatory lag is measured by RLAG1.
GULF STATES UTILITIES IS NOT INCLUDED IN THIS ANALYSIS.
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_t)\ ] * \Delta I_t \qquad (9)$$

| RLAG1 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG1 | -.016 | -4.52 | $-2.32*10^{-5}$ | -2.14 |
| ln(RLAG1) | .007 | 0.535 | -.00539 | -2.01 |
| $RLAG1^2$ | -.019 | -7.04 | $-4.72*10^{-8}$ | -2.24 |

reduction in systems from 44 to 5. Results are shown in table 13.

With the system run with quintiles instead of individual securities, the regulatory lag coefficients become significant. Whether the RLAG1 is used unaltered, logged or squared, the coefficient on the lag variable is significant at at least the .05 level. For RLAG1 and $RLAG1^2$, the coefficients are significant at the .01 level. The reduction in measurement error gained by forming quintiles allows a more powerful test of the impact of regulatory lag on interest rate sensitivity.

The tests conducted in this section lend strong support to the regulatory lag hypothesis when regulatory lag is measured as average number of days between rate case filing and rate case authorization. The following three sections will conduct similar tests for different proxies for regulatory lag.

### 6.1.2 Tests with RLAG2

As mentioned earlier, the RLAG1 measure takes into account only the time lag dimension of regulatory lag. Another dimension of regulatory lag is the "adjustment lag"--whether the granted increase is complete or partial. RLAG2 takes into account both adjustment and time lag.

Table 13: Results of SUR of equation (9) when regulatory lag is measured by RLAG1.
System is run with five portfolios (quintiles).
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_t)\ ] * \Delta I_t \qquad (9)$$

| RLAG1 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG1 | -.015 | -3.30 | $-4.28*10^{-5}$ | -2.68 |
| ln(RLAG1) | .040 | 1.78 | -.0121 | -2.93 |
| $RLAG1^2$ | -.021 | -6.74 | $-7.34*10^{-8}$ | -2.43 |

The procedure to test whether RLAG2 affects the interest rate sensitivity of utility stocks is similar to that used for RLAG1. The first test simply divides the sample into two groups--a long lag and a short lag group. The short lag group contains the 22 utilities facing the shortest state measures for RLAG2. The remaining 22 utilities fall into the long lag group. The returns to these two portfolios are then regressed against the market and interest rate proxy in a SUR of equation (8). Table 14 shows the $\beta_2$ coefficients and their standard errors. The coefficients differ in the hypothesized directions and a Wald test of the difference in the coefficients yields a chi-square statistic of 4.37 and a corresponding p-value of .034. Though weaker than the result for RLAG1, this result is further evidence that regulatory lag is affecting the interest rate sensitivity of utility stocks.

The sample is then broken down into five subgroups in an identical manner as for RLAG1. The SUR of equation (8) is run for the five portfolios. Results are found in table 15 and table 16. The results here do not support the regulatory lag hypothesis. REG1 is the least interest rate sensitive as predicted; however, the remaining subgroups do not have the relative sensitivities expected. REG2 is the most interest rate sensitive while REG3, 4 and 5 are not statistically different from each other.

The RLAG2 measure is next used as an interactive variable with the interest rate proxy. Equation (9) is estimated for

Table 14: Results of regression equation (8) for a short and long lag portfolio. Regulatory lag measure is RLAG2. Standard errors are in parentheses.

| | $\beta_0$ | $\beta_1$ | $\beta_2$ |
|---|---|---|---|
| Short Lag Portfolio | .003<br>(.0006) | .32<br>(.029) | -.026<br>(.0026) |
| Long Lag Portfolio | .002<br>(.0007) | .39<br>(.033) | -.029<br>(.0029) |

Table 15: Regression of regulatory lag portfolios on a market portfolio and an interest rate series. Regulatory lag measure is RLAG2.

| Portfolio | Market Beta | T-Statistic | I. Rate Beta | T-Statistic | $R^2$ |
|---|---|---|---|---|---|
| REG 1 | .33 | 10.4 | - .0227 | - 8.03 | .30 |
| REG 2 | .29 | 9.24 | - .0312 | - 11.2 | .34 |
| REG 3 | .40 | 11.9 | - .0247 | - 8.33 | .34 |
| REG 4 | .34 | 10.4 | - .0283 | - 9.54 | .33 |
| REG 5 | .39 | 10.9 | - .0272 | - 8.59 | .32 |

Table 16: Chi-square statistics for differences in interest rate sensitivity between portfolios with different regulatory lag. Regulatory lag measure is RLAG2.

| Portfolio | REG 1 | REG 2 | REG 3 | REG 4 | REG 5 |
|---|---|---|---|---|---|
| REG 1 | ---- | 18.5*** | .84 | 5.85** | 3.73* |
| REG 2 | | ---- | 8.70*** | 1.65 | 3.55* |
| REG 3 | | | ---- | 2.26 | 0.99 |
| REG 4 | | | | ---- | 0.20 |
| REG 5 | | | | | ---- |

Notes: * - Significant at the 10% level
** - Significant at the 5% level
*** - Significant at the 1% level

RLAG2, ln(RLAG2) and $(RLAG2)^2$ and results are found in tables 17. Each of the $\alpha_i$ coefficients is of the correct sign; however, none is statistically significant.

The interactive variable tests are repeated but with quintiles rather than individual securities and results are reported in table 18. The coefficients on the regulatory lag interacted with interest rate sensitivity are insignificant.

The results using the RLAG2 measure are much weaker than with RLAG1, suggesting that RLAG2 is a less effective measure of regulatory lag than RLAG1. Even when the portfolios are used for the interactive tests in an attempt to reduce measurement errors, results are insignificant. Of course, it is also possible that RLAG2 is a good measure of regulatory lag but that regulatory lag has little influence on the interest rate sensitivity of utility stocks.

The same measurement problems discussed for RLAG1 apply to the construction of RLAG2. The lack of data and the possibility that regulatory lags are changing over time are the two major measurement problems faced in this analysis.

### 6.1.3. Tests with RLAG3

RLAG3 modifies RLAG2 to control for the differing sizes of rate case requests and authorizations. It gives more weight when calculating regulatory lag to the larger rate cases.

Table 17: Results of SUR of equation (9) when regulatory lag is measured by RLAG2.
System is run for individual securities.
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_i)\ ] * \Delta I_t \qquad (9)$$

| RLAG2 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG2 | -.021 | -9.23 | $-9.17*10^{-9}$ | -0.19 |
| ln(RLAG2) | -.019 | -4.83 | $-2.06*10^{-4}$ | -0.46 |
| $RLAG2^2$ | -.021 | -9.26 | $-1.41*10^{-13}$ | -0.14 |

Table 18: Results of SUR of equation (9) when regulatory lag is measured by RLAG2.
System is run for five portfolios.
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_i)\ ] * \Delta I_t \qquad (9)$$

| RLAG2 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG2 | -.026 | -10.2 | $1.63*10^{-8}$ | 0.24 |
| ln(RLAG2) | -.022 | -4.70 | $-5.60*10^{-4}$ | -0.96 |
| $RLAG2^2$ | $-.02^6$ | -10.3 | $-1.12*10^{-12}$ | 0.59 |

The tests run for RLAG3 are identical to those for RLAG2 and the results are presented in tables 19 through 23.

As with the first two regulatory lag measures, the initial test which dichotomizes the sample into two subgroups gives favorable results. The subgroup with shortest regulatory lag is less sensitive to interest rates than the long lag subgroup. A wald test of the difference in the interest rate coefficients yields a chi-square statistic of 13.48 with a corresponding p-value of .0003.

The second test with five subgroups again is less conclusive. Subgroups REG1 through REG4 have successively greater interest rate coefficients as predicted by the regulatory lag hypothesis. In addition, REG1 is statistically different from each of the other subgroups. The other subgroups do not differ significantly. Additionally, REG5 does not fall in line with the other four subgroups and actually is significantly less than REG4.

The interactive tests with RLAG3 are also inconclusive. The coefficient on all RLAG3 functions is positive and significant. However, this significance is being driven in large part by the inclusion of Gulf States Utilities in the sample. When Gulf States Utilities (GSU) is removed from the sample the significance of the RLAG3 coefficient disappears. The RLAG3 variable for Louisiana is five times greater than for the next highest state. This high number is driven in large part by several rate cases pertaining to GSU. As

Table 19: Results of regression equation (8) for a short and long lag portfolio. Regulatory lag measure is RLAG3. Standard errors are in parentheses.

| | $\beta_0$ | $\beta_1$ | $\beta_2$ |
|---|---|---|---|
| Short Lag Portfolio | .003<br>(.0006) | .32<br>(.029) | -.025<br>(.0026) |
| Long Lag Portfolio | .002<br>(.0007) | .39<br>(.033) | -.030<br>(.0029) |

Table 20: Regression of regulatory lag portfolios on a market portfolio and an interest rate series. Regulatory lag measure is RLAG3.

| Portfolio | Market Beta | T-Statistic | I. Rate Beta | T-Statistic | $R^2$ |
|---|---|---|---|---|---|
| REG 1 | .33 | 10.4 | - .0217 | - 7.77 | .29 |
| REG 2 | .27 | 8.92 | - .0278 | - 10.2 | .31 |
| REG 3 | .40 | 10.7 | - .0292 | - 8.75 | .32 |
| REG 4 | .38 | 10.5 | - .0316 | - 9.66 | .33 |
| REG 5 | .39 | 11.9 | - .0277 | - 9.48 | .36 |

Table 21: Chi-square statistics for differences in interest rate sensitivity between portfolios with different regulatory lag. Regulatory lag measure is RLAG3.

| Portfolio | REG 1 | REG 2 | REG 3 | REG 4 | REG 5 |
|---|---|---|---|---|---|
| REG 1 | ---- | 8.19*** | 7.91*** | 15.6*** | 6.28** |
| REG 2 | | ---- | 0.317 | 2.64* | .00232 |
| REG 3 | | | ---- | 0.794 | 0.361 |
| REG 4 | | | | ---- | 2.96* |
| REG 5 | | | | | ---- |

Notes: * - Significant at the 10% level
** - Significant at the 5% level
*** - Significant at the 1% level

Table 22: Results of SUR of equation (9) when regulatory lag is measured by RLAG3.
System is run with individual securities.
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_i)\ ] * \Delta I_t \qquad (9)$$

| RLAG3 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG3 | -.022 | -9.63 | $3.32*10^{-7}$ | 2.65 |
| ln(RLAG3) | -.027 | -7.35 | $8.41*10^{-4}$ | 2.13 |
| $RLAG3^2$ | -.022 | -9.55 | $1.14*10^{-11}$ | 3.40 |

Note: The results in this table are highly influenced by the inclusion of Gulf States Utilities in the sample. When GSU is deleted from the sample, the $\alpha_1$ coefficients lose their significance.

Table 23: Results of SUR of equation (9) when regulatory lag is measured by RLAG3.
System is run with five portfolios.
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_i)\ ] * \Delta I_t \qquad (9)$$

| RLAG3 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG3 | -.027 | -10.0 | $1.06*10^{-7}$ | .641 |
| ln(RLAG3) | -.026 | -4.86 | $-2.98*10^{-5}$ | -.035 |
| $RLAG3^2$ | -.027 | -10.1 | $1.16*10^{-11}$ | .940 |

discussed in section 6.1.1, GSU had severe problems with a large nuclear plant in the 1980s.

When ln(RLAG3) is used, $\alpha_1$ is still significant. The use of $(RLAG3)^2$ also gives a positive and significant coefficient. The significance on both of these RLAG3 variations disappears with the deletion of Gulf States Utilities from the sample.

The significance also disappears when quintiles are used in the interactive analysis to reduce measurement error of the RLAG3 regulatory lag proxy. Results of this specification are found in table 24. None of the $\alpha_1$ coefficients are significant.

### 6.1.4. Tests with RLAG4

The same tests used for each of the three regulatory lag proxies are repeated for RLAG4. The results are presented in tables 24 through 28.

Table 24 shows that when the sample is divided into two portfolios, the portfolio facing the short regulatory lag is less interest rate sensitive than the portfolio facing the long regulatory lag. The chi-square statistic for the difference in these coefficients is 5.4 (p=.020).

When the sample is divided into five portfolios, the results in table 25 show that the five portfolios have differing interest rate sensitivities. For the first four portfolios, the interest rate sensitivity is increasing as

Table 24: Results of regression equation (8) for a short and long lag portfolio. Regulatory lag measure is RLAG4.

| | $\beta_0$ | $\beta_1$ | $\beta_2$ |
|---|---|---|---|
| Short Lag Portfolio | .002<br>(.0006) | .33<br>(.029) | -.026<br>(.0026) |
| Long Lag Portfolio | .002<br>(.0006) | .38<br>(.032) | -.029<br>(.0028) |

Note: Standard errors are in parentheses.

Table 25: Regression of regulatory lag portfolios on a market portfolio and an interest rate series. Regulatory lag measure is RLAG4.

| Portfolio | Market Beta | T-Statistic | I. Rate Beta | T-Statistic | $R^2$ |
|---|---|---|---|---|---|
| REG 1 | .32 | 9.23 | - .0197 | - 6.52 | .24 |
| REG 2 | .36 | 11.3 | - .0289 | - 9.80 | .36 |
| REG 3 | .33 | 10.0 | - .0311 | - 10.4 | .34 |
| REG 4 | .37 | 10.2 | - .0334 | - 10.1 | .34 |
| REG 5 | .40 | 11.5 | - .0217 | - 6.92 | .30 |

Table 26: Chi-square statistics for differences in interest rate sensitivity between portfolios with different regulatory lag. Regulatory lag measure is RLAG4.

| Portfolio | REG 1 | REG 2 | REG 3 | REG 4 | REG 5 |
|---|---|---|---|---|---|
| REG 1 | --- | 10.9*** | 16.1*** | 23.5*** | .351 |
| REG 2 | | --- | 0.979 | 4.07** | 6.88*** |
| REG 3 | | | --- | 1.18 | 12.3*** |
| REG 4 | | | | --- | 20.1*** |
| REG 5 | | | | | --- |

Notes: * - Significant at the 10% level
** - Significant at the 5% level
*** - Significant at the 1% level

Table 27: Results of SUR of equation (9) when regulatory lag is measured by RLAG4.
System is run with individual securities.
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_i)\ ] * \Delta I_t \qquad (9)$$

| RLAG4 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG4 | -.020 | -4.95 | $-4.88*10^{-6}$ | -0.450 |
| ln(RLAG4) | -.012 | -0.705 | $-1.61*10^{-3}$ | -0.548 |
| $RLAG4^2$ | -.020 | -7.12 | $-6.07*10^{-9}$ | -0.317 |

Table 28: Results of SUR of equation (9) when regulatory lag is measured by RLAG4.
System is run with five portfolios.
System of SUR equations:

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_i)\ ] * \Delta I_t \qquad (9)$$

| RLAG4 Function | $\alpha_0$ | T-statistic | $\alpha_1$ | T-statistic |
|---|---|---|---|---|
| RLAG4 | -.018 | -3.92 | $-2.42*10^{-5}$ | -1.67 |
| ln(RLAG4) | .021 | 0.928 | $-8.28*10^{-3}$ | -2.04 |
| $RLAG4^2$ | -.023 | -7.01 | $-3.23*10^{-7}$ | -1.28 |

expected. Again, as observed for RLAG1 and RLAG3, the interest rate sensitivity of the fifth portfolio (with the greatest regulatory lag) falls out of sequence. In fact, the fifth portfolio is significantly less interest rate sensitive than the second, third and fourth portfolios.

When the individual securities are run with the interactive regulatory lag proxies in equation (9), the coefficients on regulatory lag are of the correct sign but are not statistically significant. Table 28 shows the results when the procedure is repeated for the five quintiles instead of individual securities. The coefficient on RLAG4 is significant at the 10% level. When the natural log of RLAG4 is used, the significance increases to the 5% level.

### 6.1.5. Summary of Regulatory Lag Tests

The results in this section are generally supportive of the regulatory lag hypothesis. It should be pointed out that all of the tests are actually joint tests of 1) whether regulatory lag influences interest rate sensitivity and 2) whether the measures adopted are adequate proxies of regulatory lag. The best results obtained are with RLAG1--the number of days between rate case filing and authorization. Results are somewhat weaker when RLAG1 is altered to control for the size of individual rate cases (RLAG4) although the portfolio tests still show that regulatory lag is important.

Controlling for partial adjustment (RLAG2) and the size of individual rate cases compared to a state average rate case (RLAG3) decreases the significance of all interest rate coefficients.

With all four measures, the dichotomization of the sample into two subgroups gives significantly different estimates of the interest rate coefficients for the long and short lag groups. These results have been summarized in table 29 for easy reference. Utilities facing short lags are, on average, less sensitive to interest rate fluctuations than utilities facing long lags. The results obtained by splitting the sample into five subgroups are less conclusive. However, there are several subgroups (for each regulatory lag measure) that display differing interest rate sensitivities. For RLAG1, RLAG3 and RLAG4, the interest rate betas on the five portfolios generally increase as the regulatory lag measure increases. However, in both cases the fifth portfolio does not fall in sequence and is actually less interest rate sensitive than several of the other portfolios. The interactive tests with RLAG1 give coefficients on the regulatory lag variable that have the correct sign but are not quite significant. However, the deletion of one problem utility (Gulf States Utilities) leads to significant interactive regulatory lag coefficients.

Table 29: Summary of tests with long and short lag portfolios.

| Regulatory Lag measure | Portfolio | Interest rate coefficient | T-statistic | Chi-square statistic of difference in coefficients |
|---|---|---|---|---|
| RLAG1 | Short lag | -.029 | -7.71 | 10.22*** |
| | Long lag | -.029 | -8.81 | |
| | | | | |
| RLAG2 | Short lag | -.029 | -9.92 | 4.37** |
| | Long lag | -.029 | -10.0 | |
| | | | | |
| RLAG3 | Short lag | -.025 | -9.92 | 8.79*** |
| | Long lag | -.030 | -10.0 | |
| | | | | |
| RLAG4 | Short lag | -.026 | -9.77 | 5.41** |
| | Long lag | -.029 | -10.25 | |

Note: ** - significant at the .05 level
*** - significant at the .01 level

Table 30: Summary of regulatory lag run as an interactive variable with interest rates.
System run with five portfolios for each regulatory lag measure.

$$R_{it} = \beta_{0i} + \beta_{1i} * R_{mt} + [\ \alpha_0 + \alpha_1 * (RLAG_i)\ ] * \Delta I_t \qquad (9)$$

| Lag Measure | Regulatory Lag Coefficient | T-Statistic |
|---|---|---|
| RLAG1 | $-4.28*10^{-5}$ | -2.68*** |
| ln(RLAG1) | $-1.21*10^{-2}$ | -2.93*** |
| $RLAG1^2$ | $-7.34*10^{-8}$ | -2.43*** |
| | | |
| RLAG2 | $1.63*10^{-8}$ | 0.24 |
| ln(RLAG2) | $-5.60*10^{-4}$ | -0.96 |
| $RLAG2^2$ | $-1.12*10^{-12}$ | 0.59 |
| | | |
| RLAG3 | $1.06*10^{-7}$ | 0.64 |
| ln(RLAG3) | $-2.98*10^{-5}$ | -0.04 |
| $RLAG3^2$ | $1.16*10^{-11}$ | 0.94 |
| | | |
| RLAG4 | $-2.42*10^{-5}$ | -1.67* |
| ln(RLAG4) | $-8.28*10^{-3}$ | -2.04** |
| $RLAG4^2$ | $-3.23*10^{-7}$ | -1.28 |

Note: * - Significant at the 10% level
** - Significant at the 5% level
*** - Significant at the 1% level

When the interactive tests are run with quintiles instead of individual securities, the results for RLAG1 and RLAG4 give significant coefficients for the interacted regulatory lag variable. The results for all four regulatory lag measures are summarized in table 30. The quintile procedure decreases the measurement error of the regulatory lag proxies and leads to greater significance of the regulatory lag coefficients. Measures RLAG2 and RLAG3 still give insignificant coefficients. The partial adjustment procedure utilized to calculate these measures apparently gives no additional information about the regulatory lag.

All of the tests performed suffer from the fact that the regulatory lag proxies may be inadequate. No previous attempt in the literature has been made to quantify regulatory lag. The four measures here are an attempt in that direction and are the best that can be formulated with the data available. However, each suffers from at least two major weaknesses. First, the measures utilized in this chapter make use of data reported by regulatory commissions on rate cases. No data from the individual firms represented is included (or available). Specific data regarding the firms' perception of changes in costs would allow an additional degree of precision in measuring regulatory lag. It may also be that the firm-commission relationships that have developed over time blur the accuracy of using requested and authorized rate base increases. For instance, some commissions may have a

reputation of only allowing half of a request. Therefore, firms in these jurisdictions may then ask for twice what they feel is fair. This action is then perceived by the commission and you have a spiralling effect of rate base increases and authorizations. In other words, the traditional relationships may cause regulatory lag measures derived here to be somewhat inaccurate.

A second shortcoming is that regulatory lags may change over time. Because of limited data (i.e., not enough rate cases) the measures of regulatory lag here are constant for the entire sample period.

To conclude, the results presented in this section do lend strong support to the regulatory lag hypothesis despite the shortcomings of the available data. The results using the time lag variable are the strongest found. Though regulatory lag indeed exists, it is difficult to quantify. Therefore, tests of this hypothesis are weakened not only by the fact that the regulatory lag proxies do not include all aspects of regulatory lag but also by the fact that even those aspects included in the proxies are noisy.

## 6.2. Tests of the Fixed Income Hypothesis

To test the fixed income hypothesis, the formulation used in equation (9) is employed. The variables discussed in chapter 4 are put into the regressions as interactive variables. The system of equations is as follows:

$$R_{it} = \beta_{i0} + \beta_{i1}R_{mt} + [\alpha_0 + \alpha_1 TA_{it} + \alpha_2 DY_{it} + \alpha_3 IC_{it} + \alpha_4 PC_{it} + \alpha_5 DC_{it} + \alpha_6 DE_{it}]\Delta I_t + e_{it}$$

where,

$TA_{it}$ = total assets of firm i in period t

$DY_{it}$ = dividend yield of firm i in period t

$IC_{it}$ = interest coverage of firm i in period t

$PC_{it}$ = preferred dividend coverage of firm i in period t

$DC_{it}$ = common dividend coverage of firm i in period t

$DE_{it}$ = debt to equity ratio of firm i in period t.

Each of the six accounting variables are standardized by the industry average for each year in the sample. This procedure allows the variables to display a particular firm's deviation from the industry average in any particular year.

The results are found in table 31. Each accounting variable is first put into an abbreviated form of equation (8) by itself. Total assets, dividend yield and debt to equity ratio are all significant. The coverage variables do not show any significance. However, the coefficients increase in magnitude from interest to preferred to common coverage. This is consistent with the fixed income hypothesis since the safety of the common dividends is of most importance to fixed income investors. Preferred and interest coverages should be related to common coverage but should be less important.

Table 31: Results of system estimation with interactive accounting variables.
Specification:

$$R_{it} = \beta_{0i} + \beta_{1i}R_{mt} + [\alpha_0 + \alpha_1 TA_{it} + \alpha_2 DY_{it} + \alpha_3 IC_{it} + \alpha_4 PC_{it} + \alpha_5 DC_{it} + \alpha_6 DE_{it}]\Delta I_i + e_{it} \quad (9)$$

| Model | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_4$ | $\alpha_5$ | $\alpha_6$ |
|---|---|---|---|---|---|---|---|
| 1 | -.019<br>(8.30)* | -.0028<br>(3.84)* | | | | | |
| 2 | -.012<br>(2.91)* | | -.0095<br>(2.88)* | | | | |
| 3 | -.021<br>(6.06)* | | | -.0004<br>(.151) | | | |
| 4 | -.019<br>(5.35)* | | | | -.0016<br>(.582) | | |
| 5 | -.018<br>(4.90)* | | | | | -.0032<br>(.983) | |
| 6 | -.030<br>(8.41)* | | | | | | +.0087<br>(3.15)* |
| 7 | -.021<br>(4.55)* | -.0026<br>(3.72)* | -.011<br>(3.60)* | | | | +.012<br>(4.12)* |

* - significant at the .01 level

Total assets, dividend yield and debt to equity ratio are then run together in equation (8). The final line of table 31 shows that when all three are run together, each variable is still significant at the .01 level.

## 6.3. Economic Significance of Fixed Income Variables

Though the variables may be statistically significant, the economic significance may be minimal. In this section, I look at the economic significance of the results from the last model tested which includes dividend yield, total assets and debt to equity ratio. The statistical results are found on the last line of table 31 in model 7.

Each of the explanatory variables has a mean of 1 because each observation was standardized by the average of that variable in the year the observation occurred. For example, a dividend yield of 8% for Duke Power Corp. in a year where the average dividend yield is 6% gives a standardized dividend yield of 8/6 = 1.33. Because the actual yields are standardized by the average yield, the average standardized yield for any particular year will be 1. Also, the average over the entire 10 year period will be 1.

Since the average for each standardized variable is 1, the interest rate sensitivity of an "average" firm can be calculated by assuming an observation of 1 for each of the three explanatory variables. For the coefficients generated

in model 7 of equation (9), the average firm will display an interest rate sensitivity of -.023. This is calculated as [ -.021 + (-.0027)(1) + (-.011)(1) + (.012)(1)] = -.023. For a 100 basis point rise in interest rates, the return to the average electric utility stock is -2.3%.

The smallest coefficient in model 7 is on standardized total assets. However, of the three explanatory variables, total assets is the most variable. Table 32 gives some descriptive statistics of the three variables. The standard deviation of standardized total assets is approximately three times greater than that of the other two variables. The largest 10% of the utilities in the sample have a standardized total assets of greater than 2.48 meaning that these firms are at least 2.48 times the size of an average firm. For an otherwise average firm with standardized total assets of 2.48, the interest rate sensitivity is [ -.021 + (-.0027)(2.48) + (-.011)(1) + (.012)(1)] = -.0270. This sensitivity is about 17% greater than that of the average firm.

The coefficient on standardized dividend yield is larger than that of standardized total assets, but the variation of the variable is less. The range of values for standardized dividend yield is zero (for those firms that omitted dividends) to 2.31. The top 10% of firms have standardized yields of at least 1.245. A firm that is of average size and average capital structure for the industry in this time period but is at the 90th percentile of dividend yield would have an

Table 32: Statistics of fixed income explanatory variables

| Variable | Mean | Standard Deviation | Minimum | Maximum | 10th percentile | 90th percentile |
|---|---|---|---|---|---|---|
| Total Assets | 1.00 | 0.943 | 0.0183 | 4.07 | 0.116 | 2.486 |
| Dividend Yield | 1.00 | 0.299 | 0.000 | 2.31 | 0.767 | 1.245 |
| Debt/ Equity | 1.00 | 0.355 | 0.503 | 5.57 | 0.755 | 1.245 |

interest rate sensitivity of [ -.021 + (-.0027)(1) + (-.011)(1.245) + (.012)(1)] = -.0254. This is approximately 10% greater than the average for the industry.

The magnitude of the debt/equity ratio coefficient is similar to that for dividend yield except for the sign. An increase in the debt equity ratio decreases the interest rate sensitivity of utility stocks. The variation in this variable is also similar to that of dividend yield. The range is from zero to 5.57 and the top 10% of firms have standardized debt/equity ratios of 1.245 (yes, exactly that of standardized dividend yield). A firm at the 90th percentile of debt/equity ratio that has average yield and size will display an interest rate sensitivity of [ -.021 + (-.0027)(1) + (-.011)(1) + (.012)(1.245)] = -.0198. The sensitivity is 13% less than that of the average utility.

The most interest rate sensitive utilities would thus be those large firms with high yields and low debt/equity ratios. Further analysis is performed to determine if these factors are correlated with each other. The correlations are all very slightly positive. Regressions are run of each variable on the others in simple regressions and none of the three variables is significant in explaining the variation in the other variables. Therefore, the prior analysis which holds the levels of two variables at the average and varies the remaining variable is appropriate. There is no within sample

empirical support for the idea that these variables are correlated in any fashion.

In addition to being statistically significant, these three variables (total assets, dividend yield, and debt/equity ratio) are indeed economically significant. The interest rate sensitivity is impacted in an economically meaningful manner by these variables. Additionally, the effects of these variables on the sensitivity is of roughly the same order. None can be said to be more significant than the others.

## 6.4. Test with Fixed Income and Regulatory Lag Proxies

The final specification includes the three fixed income proxies and the RLAG1 measure for regulatory lag. Recall that the RLAG1 measure gave the strongest results in the tests of the regulatory lag hypothesis. However, any shortcomings in detecting significance in the regulatory lag tests could be a result of misspecification of the model. Specifically, the correct specification should include not only the regulatory lag measure but also the fixed income measures which have been shown to be significant in section 6.2. Equation (9) is modified to include the RLAG1 measure:

$$R_{it} = \beta_{i0} + \beta_{i1}R_{mt} + [\alpha_0 + \alpha_1 TA_{it} + \alpha_2 DY_{it} + \alpha_3 DE_{it} + \alpha_4 RLAG1_{it}]\Delta I_t + e_{it} \qquad (10)$$

Table 33: Results of system estimation with interactive accounting variables and regulatory lag as measured by RLAG1.
Specification:

$$R_{it} = \beta_{0i} + \beta_{1i}R_{mt} + [\alpha_0 + \alpha_1 TA_{it} + \alpha_2 DY_{it} + \alpha_3 DE_{it} + \alpha_4 RLAG1_{it} + \alpha_5 \ln(RLAG1)_{it} + \alpha_6 (RLAG1)^2_{it}]\Delta I_t + e_{it}$$

| Model | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_4$ | $\alpha_5$ | $\alpha_6$ |
|---|---|---|---|---|---|---|---|
| 1 | -.020 | -.0026 | -.010 | +.012 | $-1.3*10^{-5}$ | | |
| | (4.30)* | (3.84)* | (2.98)* | (3.45)* | (0.342) | | |
| 2 | -.016 | -.0026 | -.010 | +.012 | | $-7.58*10^{-4}$ | |
| | (2.09)* | (3.41)* | (3.00)* | (4.12)* | | (0.273) | |
| 3 | -.020 | -.0026 | -.010 | +.012 | | | $-6.73*10^{-9}$ |
| | (4.42)* | (3.46)* | (2.96)* | (4.12)* | | | (0.311) |

Note: * - significant at the .01 level

This specification is run for RLAG1, ln(RLAG1) and $(RLAG1)^2$. The results are found in table 33.

Again the coefficients on the RLAG1 measures are in the correct direction but insignificant. The significance drops from the specification that includes only the regulatory lag measures. The coefficients on the fixed income variables are very close to those in the specification without RLAG1.

# CHAPTER 7
# DIRECTIONS FOR FUTURE RESEARCH

This chapter addresses directions for research suggested by this study. Several of these areas I personally hope to pursue upon graduation, while others are suggested that may be more closely related to other studies.

The most obvious place to extend this research is in the calculation of regulatory lags. The measures constructed in this study make use of a new data set on regulatory rate cases. The shortcomings of these measures are discussed in section 6.1.5. The noisiness of the regulatory lag measures due to scarcity of data is difficult to remedy. While the data in PUF does not contain every rate case in the sample period, no other source is more complete. Cross referencing the PUF data with other sources may allow the inclusion of more rate cases. However, the additional rate cases will be few. For several states, I checked sources such as Moody's Utility Manual, the NARUC Annual Report, and annual reports. Only one rate case for each of two states was found that had been missing from the PUF data.

The possibility that regulatory lag may be changing over time might be addressed by specifying a dynamic regulatory lag

structure. Again the lack of data for many states would make the specification difficult to fit.

The regulatory lag measures may not be taking all aspects of regulatory lag into account. The time period between when costs rise and when prices rise to completely reflect cost changes is the total regulatory lag. In this analysis, the four variations of the time between filing and authorization of a rate case are used to proxy for the regulatory lag. Other proxies may be identified which more completely gauge the entire regulatory lag period.

Since a main conclusion in this study is that the fixed income nature of utilities highly influences their interest rate sensitivity, stocks in other industries might be examined for these same effects. As pointed out in Sweeney and Warga (1986), the utility industry as a whole is the only industry displaying consistent sensitivity to interest rates. However, there may be a handful of stocks in any given industry that pay higher than average dividends. If interest rate sensitivity of these stocks in other industries could be documented, more support could be lent to the fixed income hypothesis. Industries such as the steel industry, packaging and container industry, and petroleum industry all have several firms that pay dividends comparable to high-yielding utilities.

Whether the interest rate sensitivity is perceived as a risk factor in an arbitrage pricing theory (APT) context could

also be examined. This issue is especially interesting if the regulatory environment is impacting the interest rate sensitivity. If long lags lead to higher interest rate risk, regulatory actions could be affecting firms' cost of capital. The cost of equity is increased as investors require higher returns to compensate for added risk.

A recent practitioners article published by Salomon Brothers shows that utilities which reduce dividends outperform the industry and market in the year following the reduction. The authors note that this finding is consistent with an overreaction by utility investors upon the announcement of reduction. This overreaction becomes even more probable with the demonstration in this study that the fixed income nature of utilities greatly affects the characteristics of their stocks. With the reduction or omission of a dividend, the fixed income stream is reduced or eliminated. If most utility stock investors are fixed income investors, the rapid flight out of a dividend-reducing utility would give rise to the overreaction observed. Further research might reconcile the fixed income hypothesis with the Salomon Brothers results.

# CHAPTER 8
# CONCLUSION

This study lends strong support to the *fixed income hypothesis*. A utility's dividend yield is highly significant in explaining stock sensitivity to interest rate fluctuations. The higher the yield, ceteris paribus, the greater the interest rate sensitivity. Under the fixed income hypothesis, a higher yield makes a stock more attractive to investors interested in a fixed income stream. As investors substitute the high yielding utilities for true fixed income instruments, the utility stocks display interest rate sensitivity characteristic of bonds and CDs.

The size of a utility as measured by total assets is also significant in explaining the interest rate sensitivity of utility stocks. Large firms are more sensitive than smaller firms. Presumably large utilities are seen as more viable companies with more stable dividend streams. The size of the firm proxies for the perceived safety of the dividend stream. Safer dividend streams tend to look more like the promised coupon payments of bonds and cause the stock to behave in a more bond-like manner with regard to the interest rate sensitivity.

Additionally, the debt to equity ratio affects interest rate sensitivity of utility stocks. More highly levered firms are less interest rate sensitive. This result may occur because dividend payments which are subordinate to a large amount of coupon payments are less safe than those which are subordinate to a relatively small amount of coupon payments. The debt to equity ratio may be a measure of the safety of the dividend stream. However, the fact that equity holders (of any firm) benefit at the expense of bondholders when interest rates rise is likely manifested in the significance of debt to equity ratio on interest rate sensitivity.

The analysis also provides evidence of a regulatory lag effect in the interest rate sensitivity of utility stocks. These results are less robust than those found in relation to the fixed income hypothesis. When regulatory lag is measured as the time between rate case filing and authorization, the lag appears to influence the interest rate sensitivity. Longer lag utilities are more sensitive to interest rates. When the regulatory lag measures are combined with the fixed income proxies, regulatory lag has the correct sign but is insignificant. However, as mentioned in chapter 6, the measure suffers from data problems.

## APPENDIX

This appendix derives the relationship between returns and changes in inflation for utility stocks that are sensitive to changes in inflation. The basic results are as follows. For increasing inflation, stock returns decrease at a decreasing rate as regulatory lag lengthens. For decreases in inflation, stock returns increase at a increasing rate as regulatory lag lengthens. The relationship between the real rate and the expected inflation is not important at reasonable real rate levels.

The proof will proceed as follows. A three period model will be assumed as in chapter 3. Three firms identical in all respects except regulatory lag will be considered. Firm 1 has a one period lag, firm 2 faces a two period lag and firm 3 faces a three period lag. The analysis will compare the differences in returns to these firms under different real rate and inflation rate assumptions.

The stock price of each firm is simply the sum of the discounted cash flows over the three periods. The output of each firm will be identical in all periods and could be sold at a time zero price of X dollars. Without a change in inflation expectations, the price of all three firms' stock is the same. With a change in inflation, the stock prices

diverge because of the differential effects of each firms' regulatory lag on the subsequent cash flows. The return to the stock upon the realization of an inflation change is simply the difference between the price before and after the change divided by the price before the change. The inflation change occurs at time zero. At that point the stock prices change to reflect how the new inflation rate combined with the regulatory lag will affect the stock price.

Define the following terms:

$P_b$ = Price of all stocks before inflation expectation change

$P_{1a}$ = Price of stock 1 after inflation expectation change

$P_{2a}$ = Price of stock 2 after inflation expectation change

$P_{3a}$ = Price of stock 3 after inflation expectation change

$I_b$ = Inflation expected before change

$I_a$ = inflation expected after change

$r$ = real rate

$X$ = price of output at time zero

The return to stock 1 is:

$$R_i = (P_{1a} - P_b)/P_b$$

$$= P_{1a}/P_b - 1$$

where,

$$P_{b1}=\frac{X(1+I_b)}{(1+r)(1+I_b)}+\frac{X(1+I_b)^2}{((1+r)(1+I_b))^2}+\frac{X(1+I_b)^3}{((1+r)(1+I_b))^3}$$

$$P_{a1}=\frac{X(1+I_b)}{(1+r)(1+I_a)}+\frac{X(1+I_a)^2}{((1+r)(1+I_a))^2}+\frac{X(1+I_a)^3}{((1+r)(1+I_a))^3}$$

Transform the denominator for these equations to:

$(1+r)^3*(1+I_a)^2$

$$P_b=\frac{X(1+I_b)(1+r)^2(1+I_a)^3}{(1+r)^3(1+I_a)^3(1+I_b)}+\frac{X(1+I_b)^2(1+r)(1+I_a)^3}{(1+r)^3(1+I_a)^3(1+I_b)^2}+\frac{X(1+I_b)^3(1+I_a)^3}{(1+r)^3(1+I_a)^3(1+I_b)^3}$$

$$P_b=\frac{X[(1+r)^2(1+I_a)^3+(1+r)(1+I_a)^3+(1+I_a)^3]}{(1+r)^3(1+I_a)^3}$$

$$P_{a1}=\frac{X(1+I_b)(1+r)^2(1+I_a)^2}{(1+r)^3(1+I_a)^3}+\frac{X(1+r)(1+I_a)^3}{(1+r)^3(1+I_a)^3}+\frac{X(1+I_a)^3}{(1+r)^3(1+I_a)^3}$$

$$P_{a1}=\frac{X[(1+I_b)(1+r)^2(1+I_a)^2+(1+r)(1+I_a)^3+(1+I_a)^3]}{(1+r)^3(1+I_a)^3}$$

The return to stock 1 can now be written:

$$R_1=\frac{[(1+I_b)(1+r)^2(1+I_a)^2+(1+r)(1+I_a)^3+(1+I_a)^3]}{[(1+r)^2(1+I_a)^3+(1+r)(1+I_a)^3+(1+I_a)^3]}-1$$

We can compare the difference in returns to stocks 1 and 2 with the difference in returns to stocks 2 and 3 to see whether interest rate sensitivity increases at an increasing or decreasing rate with regulatory lag. The prices of and returns to stocks 2 and 3 can be calculated in the same manner as for stock 1:

$$P_{a2}=\frac{X(1+I_b)}{(1+r)(1+I_a)}+\frac{X(1+I_b)^2}{((1+r)(1+I_a))^2}+\frac{X(1+I_a)^3}{((1+r)(1+I_a))^3}$$

$$P_{a2}=\frac{X(1+I_b)(1+r)^2(1+I_a)^2}{(1+r)^3(1+I_a)^3}+\frac{X(1+r)(1+I_b)^2(1+I_a)}{(1+r)^3(1+I_a)^3}+\frac{X(1+I_a)^3}{(1+r)^3(1+I_a)^3}$$

$$P_{a2}=\frac{X[(1+I_b)(1+r)^2(1+I_a)^2+(1+r)(1+I_b)^2(1+I_a)+(1+I_a)^3]}{(1+r)^3(1+I_a)^3}$$

$$R_2=\frac{[(1+I_b)(1+r)^2(1+I_a)^2+(1+r)(1+I_b)^2(1+I_a)+(1+I_a)^3]}{[(1+r)^2(1+I_a)^3+(1+r)(1+I_a)^3+(1+I_a)^3]}-1$$

For Stock 3:

$$P_{a3}=\frac{X(1+I_b)}{(1+r)(1+I_a)}+\frac{X(1+I_b)^2}{((1+r)(1+I_a))^2}+\frac{X(1+I_b)^3}{((1+r)(1+I_a))^3}$$

$$P_{a3}=\frac{X(1+I_b)(1+r)^2(1+I_a)^2}{(1+r)^3(1+I_a)^3}+\frac{X(1+r)(1+I_b)^2(1+I_a)}{(1+r)^3(1+I_a)^3}+\frac{X(1+I_b)^3}{(1+r)^3(1+I_a)^3}$$

$$P_{a3}=\frac{X[(1+I_b)(1+r)^2(1+I_a)^2+(1+r)(1+I_b)^2(1+I_a)+(1+I_b)^3]}{(1+r)^3(1+I_a)^3}$$

$$R_3=\frac{[(1+I_b)(1+r)^2(1+I_a)^2+(1+r)(1+I_b)^2(1+I_a)+(1+I_b)^3]}{[(1+r)^2(1+I_a)^3+(1+r)(1+I_a)^3+(1+I_a)^3]}-1$$

The question to be answered is whether the interest rate sensitivity increases at an increasing or decreasing rate with regulatory lag. This question will be answered by comparing the difference in returns to stocks 1 and 2 with the difference in returns to stocks 2 and 3.

After examining the returns to stock 1 and 2, the only difference is the second term in the numerator of $R_1$ and $R_2$. In the case of $R_2$ and $R_3$, only the third term in the numerator differs. Thus to determine whether there is a larger change in return from stock 1 to stock 2 or stock 2 to stock 3 can be determined by examining only these portions of the return equations. The difference in returns to stocks 1 and 2 and stocks 2 and 3 are, respectively:

$$D_{12} = (1+r)(1+I_b)^2(1+I_a) - (1+r)(1+I_a)^3$$

$$D_{23} = (1+I_b)^3 - (1+I_a)^3$$

Numerical simulations were performed with values of r, $I_a$ and $I_b$ between 0 and 20% to determine the effects of regulatory lag on inflation sensitivity for various inflation rate-real rate combinations. Following is a list of results obtained:

1. For values of $I_b$ greater than $I_a$, interest rate sensitivity increases at an increasing rate. In other words, as expectations of inflation fall, lengthening the regulatory lag increases the interest rate sensitivity at an increasing rate.

2. For values of $I_a$ greater than $I_b$, interest rate sensitivity increases at a decreasing rate. As expectations of inflation rise, lengthening the regulatory lag increases the interest rate sensitivity at a decreasing rate.

3. The value of the real rate does not affect the analysis for reasonable levels of the real rate. In the simulations conducted, the lowest real rate that affects conclusions (1) and (2) is 44%.

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## BIOGRAPHICAL SKETCH

Edward O'Neal was born September 25, 1963, in Gainesville, Florida, while his father was completing his Ph.D. at the University of Florida. He received the Bachelor of Science in electrical engineering from North Carolina State University in 1986. He attended N.C. State when the Wolfpack won the NCAA basketball championship in 1983--an event which had great impact on his life. Married in 1986 to Miss Varina Lee Ivey, Edward returned to school at Auburn University in 1987 from which he received the master's degree in business administration in 1989.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Mark Flannery, Chairman
Barnett Banks Eminent Scholar of Finance

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Eugene Brigham
Graduate Research Professor of Finance, Insurance and Real Estate

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Michael Ryngaert
Associate Professor of Finance, Insurance and Real Estate

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Sanford Berg
Florida Public Utilities Professor

This dissertation was submitted to the Graduate Faculty of the Department of Finance, Insurance and Real Estate in the College of Business Administration and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August, 1993

Dean, Graduate School